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Visual Approach Data Collection at St. Louis Lambert Field (STL)

Final Report

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January 1993

DOT/FAA/CT-TN93/2

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U.S. Department of Transportation
Federal Aviation Administration

Technical Center
Atlantic City International Airport, N.J. 08405

NOTICE

ACKNOWLEDGEMENTS

We would like to thank the many individuals who made significant contributions towards this study. A considerable amount of effort was required to plan, prepare, collect, and reduce the data in this study.

We especially appreciate the assistance provided by the following people at the St. Louis TRACON: Bill Leingang, the Facilities Manager, for allowing us into his facility; Brooks Wilson, Elmer McKean, Jim Kitson, Fred Cater, Rich Taylor, and Fred Carson of Airways Facilities for their patience and for the quality and depth of their contributions. Their efforts and creative solutions allowed us to successfully interface with facility equipment without impacting ATC operations.

We appreciate the efforts made by Ed Butterly, CTA INCORPORATED, for assistance with on-site equipment set up and test, monitoring of data collection, software engineering support, unpacking, reduction, and analysis of collected data, and technical assistance for the final report.

We would also like to recognize the contributions of the Washington Program Sponsor, Jim Moreland, who provided project guidance and substantial statistical and data analysis support.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN93/2		

4. Title and Subtitle VISUAL APPROACH DATA COLLECTION AT ST. LOUIS LAMBERT FIELD (STL)	5. Report Date January, 1993 6. Performing Organization Code ACD-340
7. Author(s) James Thomas, Dominic Timoteo, and Amy E. Transue	8. Performing Organization Report No. DOT/FAA/CT-TN93/2
9. Performing Organization Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. F2006G
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405	13. Type of Report and Period Covered Technical Note August 2-October 23, 1990 14. Sponsoring Agency Code ACD-340

15. Supplementary Notes

16. Abstract

Data on aircraft executing simultaneous visual approaches to closely spaced parallel and intersecting runways were collected at Lambert-St. Louis International Airport (STL) between August 2 and October 23, 1990. The purpose of the data collection was to provide an accurate data base of the navigational characteristics of aircraft flying the "fly visual" segment of the approach. Aircraft position data were collected using the in-place STL surveillance primary and secondary radars.

The data were reduced and a limited analysis was performed at the Federal Aviation Administration (FAA) Technical Center by ATC Technology (ACD-340) personnel. The discussion in the Final Report concerns the accuracy of the collected position data and possible sources of error in the data collection. The reduced data were sent to the Standards Development Branch (AVN-540) for further analysis. AVN-540 will report on their findings and recommendations.

17. Key Words	18. Distribution Statement
Lambert Field St. Louis International Airport Visual Approach	Document is available to the U.S public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	59	

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

Current Federal Aviation Administration (FAA) regulations allow all nonprecision and precision Category I and Category II approach and landing operations to include a transition from instrument flight rules to visual flight rules, followed by a "fly visual" segment to complete the landing. As a means for increasing airport capacity, numerous "fly visual" concepts have been envisioned; simultaneous charted visual approaches to closely spaced parallel runways, simultaneous instrument approaches to closely spaced runways, simultaneous visual approaches to intersecting runways, and simultaneous converging instrument approaches to intersecting runways. To date, very little qualitative and quantitative data are available for use in evaluating the safety of these concepts.

The Standards Development Branch (AVN-540), at the Mike Monroney Aeronautical Center, Oklahoma City, requested that data be collected to be used to formulate criteria for conducting simultaneous visual operations to parallel runways having spacing less than established standards and to converging runways. The Dual Sensor Receiver and Processor (DUALSRAP) data collection system, previously used to collect data at the Chicago O'Hare International Airport (ORD) and San Francisco International (SFO) was modified to collect the necessary data. The system used position reports generated by the Airport Surveillance Radars (ASR-7, ASR-8) along with their associated secondary radars, the Air Traffic Control Beacon Interrogators (ATCBI-4, ATCBI-5). Data were collected on arriving targets-of-opportunity to Lambert-St. Louis International Airport (STL). These arriving aircraft had to be equipped with Mode C/S transponders while conducting Localizer Directional Aid (LDA) approaches to runways 12L and 30L, and approaches to runways 06, 12L, 12R, 24, 30L, and 30R. The data collection began August 1990, and continued until October 1990, when the required number of approximately 3000 tracks had been recorded. Voice recordings of all communications between observed aircraft and air traffic control (ATC) were also obtained, along with accurate and timely weather data.

Data extraction and reduction was performed at the FAA Technical Center, resulting in smooth track files and various plots of the data. The reduced track data files and their plots were forwarded to AVN-540. A Master Database was also generated containing pertinent data related to track identification and environmental conditions considered important to the analysis. A limited data analysis was performed at the FAA Technical Center in order to determine the overall accuracy of the collected data. AVN-540 will conduct the final analysis of the reduced data and report on their findings and recommendations.

1. INTRODUCTION.

This report describes the data collection and reduction methodology that was employed to provide the Standards Development Branch, AVN-540, with the data they requested. These data were part of an operational test and evaluation of the visual segment of approaches to runways 12L and 12R, 30L and 30R, 06 and 12L, and 24 and 30L at Lambert-St. Louis International Airport (STL). This is intended to accomplish the following:

a. Describe the data collection and data reduction hardware and software.

b. Specify the data collection and data reduction procedures.

c. Describe the deliverables provided by ATC Technology Branch (ACD-340).

d. Discuss general conclusions derived from preliminary ACD-340 data analysis.

e. Provide the milestone project schedule.

1.1 OBJECTIVES.

The objective of this effort was to provide an accurate database of the navigational accuracy of aircraft flying the visual approaches to closely spaced parallel and intersecting runways at STL under different environmental conditions. This database will be used by AVN-540 to determine the acceptability of certain fly visual approach and landing operations associated with operations conducted under Instrument Flight Rules (IFR). The database will also be used to develop criteria for use in determining the operating minimums, operational criteria, and operational procedures related to these operations.

1.2 BACKGROUND.

Airport capacity remains a critical issue for the Federal Aviation Administration (FAA). The ability of a highly active airport to operate at its optimal capacity is crucial to daily operations. One method to maintain airport capacity is to permit separation based on the fly visual concept during the final segment of the approach. Operations based on IFR separation have not accommodated the capacity requirements at specific airports. The increases in traffic, plus the limited number of parallel and converging runways where simultaneous IFR operations can be applied, have led to the increased use of the fly visual concept in operations. The fly visual concept provides standard IFR separation until the aircraft arrive at a point where visual separation must be established by either the pilots or the controller. In simultaneous fly visual operations, this usually occurs just prior to arriving at the point where the two flightpaths converge to the required minimum IFR lateral separation distance. Very little qualitative and quantitative data are available to be used to evaluate the safety of numerous fly visual concepts. These concepts include simultaneous instrument approaches to closely spaced runways, simultaneous visual approaches to closely spaced runways, simultaneous visual approaches to intersecting runways, and simultaneous converging instrument approaches to intersecting runways. Flight standards are needed to establish criteria and operational requirements necessary

to safely conduct these operations for closely spaced parallel runways which have a fly visual segment (based on visual separation), as well as to converging runways (Hasman, 1989).

2. RELATED PROJECTS AND DOCUMENTATION.

A work effort conducted by ACD-340, under the Capacity Studies project, F20-06A, resulted in the development and employment of the Dual Sensor Receiver and Processor (DUALSRAP) Data Collection System. The DUALSRAP System collected data from a Sensor Receiver and Processor (SRAP) which was connected to the source of radar data. The source consisted of an Airport Surveillance Radar (ASR)-7 and an ATC Beacon Interrogator (ATCBI)-4. This system was used to characterize the Instrument Landing System (ILS) navigational performance of a typical mix of today's aircraft, and to determine the degree of containment within several hypothetical Normal Operating Zones (NOZ) smaller than presently allowed. The system was set up at Chicago O'Hare International Airport from January through March 1989 to collect a database of over 3000 simultaneous ILS approaches. The DUALSRAP Data Collection System was employed by this project with some system modifications. System modifications included termination of data collection at a preset time and modification of system defaults for STL data collection. Additional software was used to facilitate automatic start up of data collection and provide for remote monitoring and control of data collection. Additionally, a local area network was installed to provide the ability for on-site data reduction and expanded computing power. A more detailed description of the DUALSRAP Data Collection System was supplied by J. Thomas and D. Timoteo (Thomas, 1990).

3. PROJECT IMPLEMENTATION.

The primary data for this study were radar tracks of aircraft flying visual approaches to runways 12L and 12R, 30L and 30R, 06 and 12L, and 24 and 30L at STL. Airport diagrams are shown in figures 1 through 9. In order to extract the maximum information from these data, secondary data collected included the precise weather conditions during the approach, the type of aircraft, the aircraft's beacon code and identification, and the approach fix for each aircraft.

The project phases were divided into data collection, data extraction and reduction with limited analysis, and data output to Flight Standards. In addition, system support software was modified as needed to accomplish the project goals.

4. DATA COLLECTION.

4.1 DATA COLLECTION HARDWARE.

4.1.1 Data Collection System Hardware Description.

The data collection system was installed at the STL Terminal Radar Approach Control (TRACON) (shown in figure 10). It consisted of the following hardware:

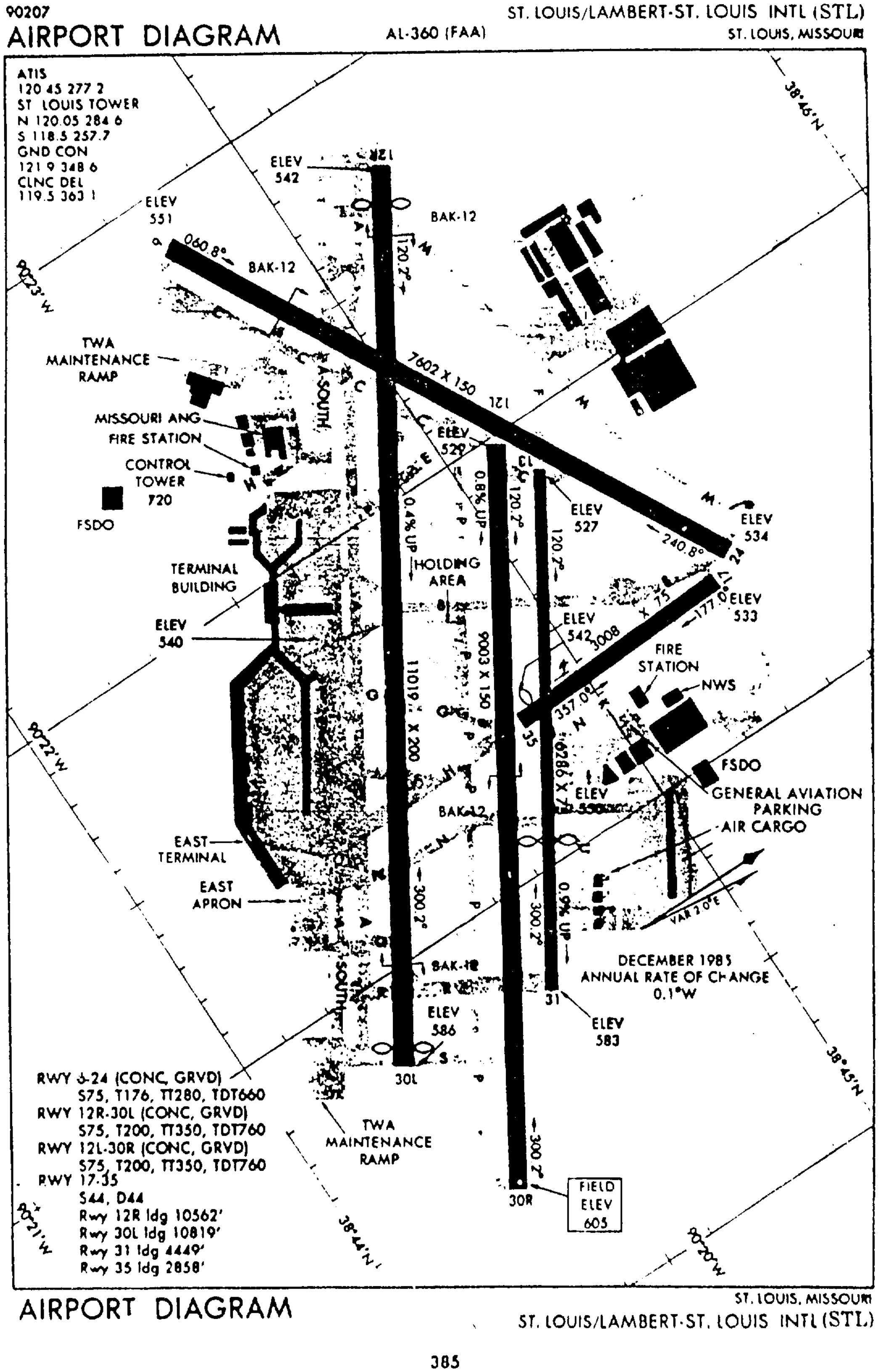
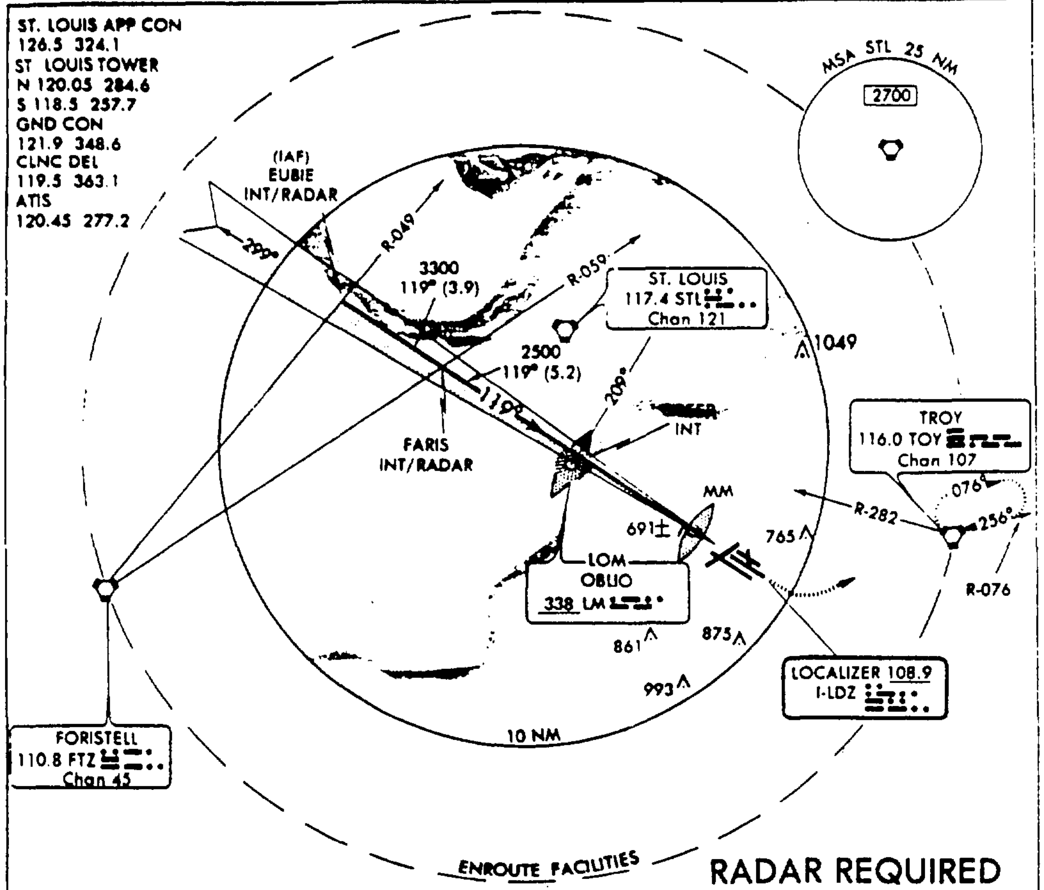


FIGURE 1. LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

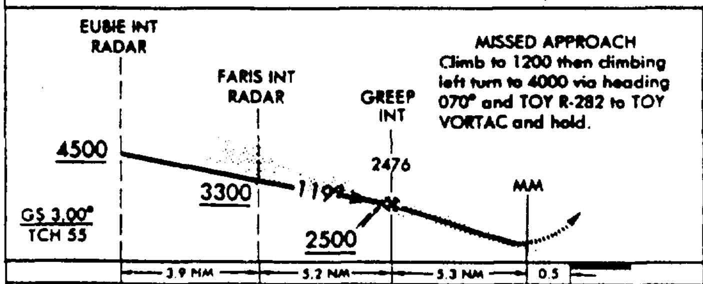
Amdt 2 89236

ILS RWY 12L

AL-350 (FAA) ST. LOUIS/LAMBERT-ST. LOUIS INTL (STL)
ST. LOUIS, MISSOURI

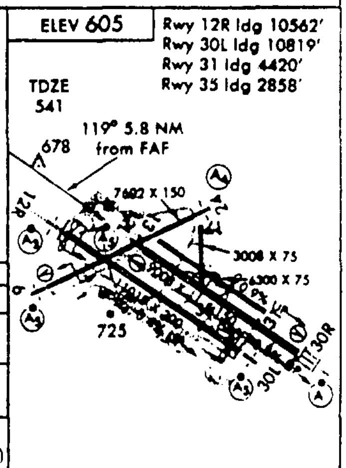


RADAR REQUIRED



CATEGORY	A	B	C	D	E
S-ILS 12L	741/18 200 (200-½)				741/24 200 (200-½)
S-LOC 12L	960/24 419 (400-½)		960/40 419 (400-¾)		960/50 419 (400-1)
CIRCLING	1060-1 455 (500-1)		1060-1½ 455 (500-1½)	1160-2 555 (600-2)	1320-2½ 715 (800-2½)

Cat D S-LOC 12L visibility increased to 5000 RVR for inoperative MM.
Cat E S-ILS 12L visibility increased to 4000 RVR and Cat. E S-LOC 12L visibility increased to 1½ miles for inoperative MALSR.



HIRL all Rwys
TDZ/CL Rwys 12L, 12R and 30R

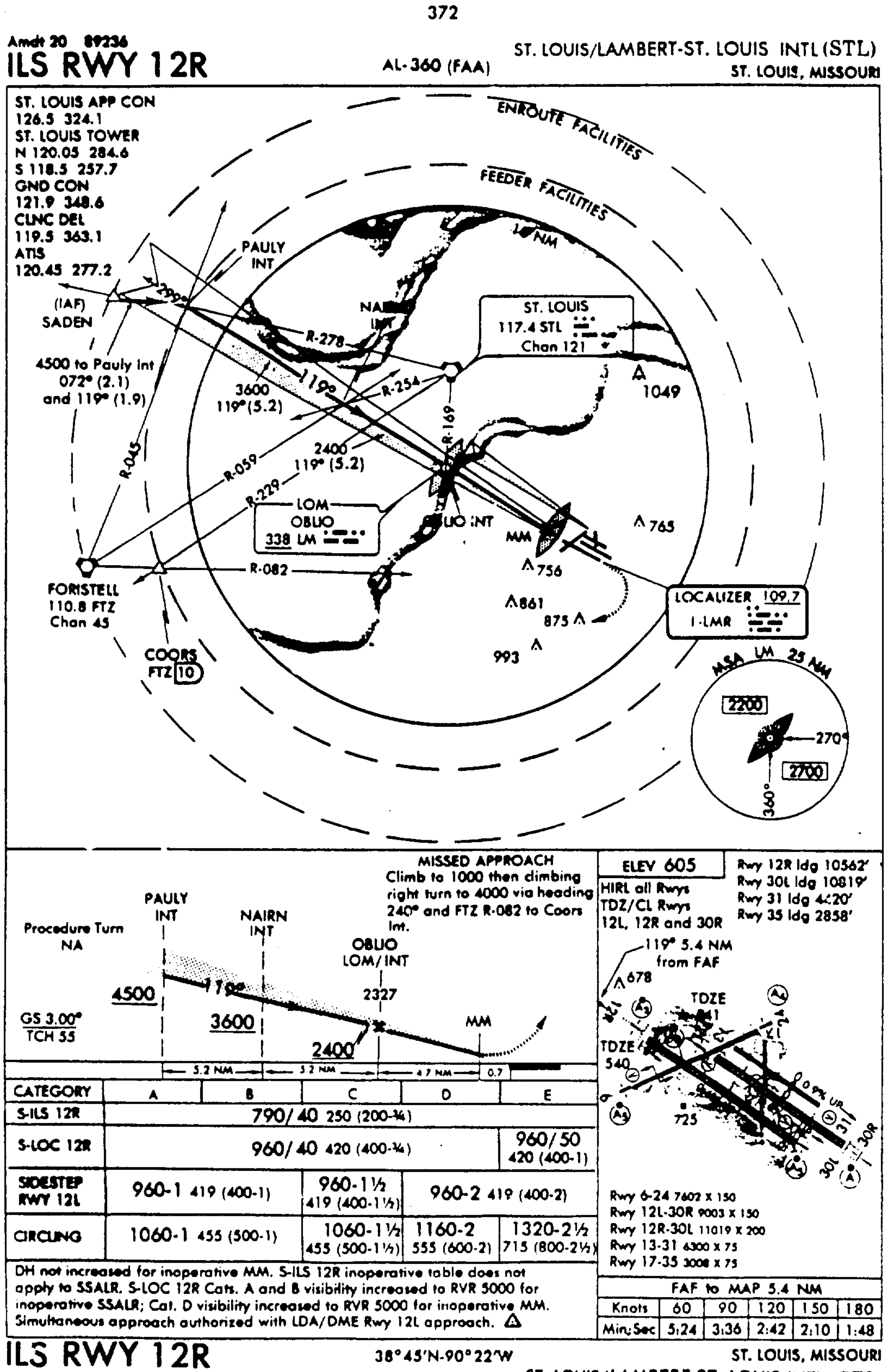
FAF to MAP 5.8 NM

Knots	60	90	120	150	180
Min:Sec	5:48	3:52	2:54	2:19	1:56

ILS RWY 12L 38°45'N-90°22'W ST. LOUIS, MISSOURI
ST. LOUIS/LAMBERT-ST. LOUIS INTL (STL)

371

FIGURE 2. STL CHARTED ILS RWY 12L APPROACH PLATE



CATEGORY	A	B	C	D	E
S-ILS 12R	790/40 250 (200-½)				
S-LOC 12R	960/40 420 (400-¾)				960/50 420 (400-1)
SIDESTEP RWY 12L	960-1 419 (400-1)		960-1½ 419 (400-1½)	960-2 419 (400-2)	
CIRCLING	1060-1 455 (500-1)		1060-1½ 455 (500-1½)	1160-2 555 (600-2)	1320-2½ 715 (800-2½)

DH not increased for inoperative MM. S-ILS 12R inoperative table does not apply to SSALR. S-LOC 12R Cats. A and B visibility increased to RVR 5000 for inoperative SSALR; Cat. D visibility increased to RVR 5000 for inoperative MM. Simultaneous approach authorized with LDA/DME Rwy 12L approach.

FAF to MAP 5.4 NM					
Knots	60	90	120	150	180
Min:Sec	5:24	3:36	2:42	2:10	1:48

FIGURE 3. STL CHARTED ILS RWY 12R APPROACH PLATE

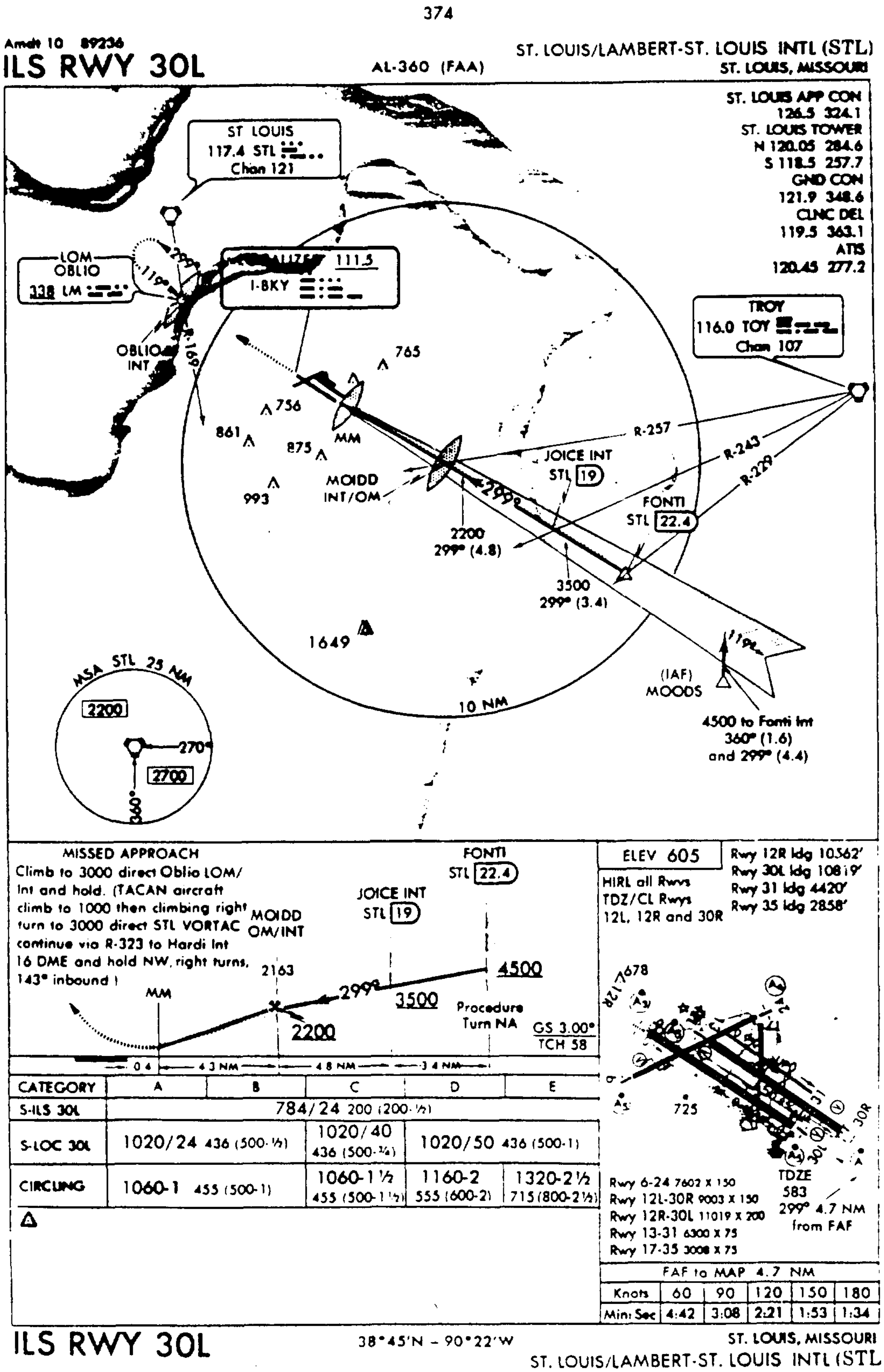


FIGURE 4. STL CHARTED ILS RWY 30L APPROACH PLATE

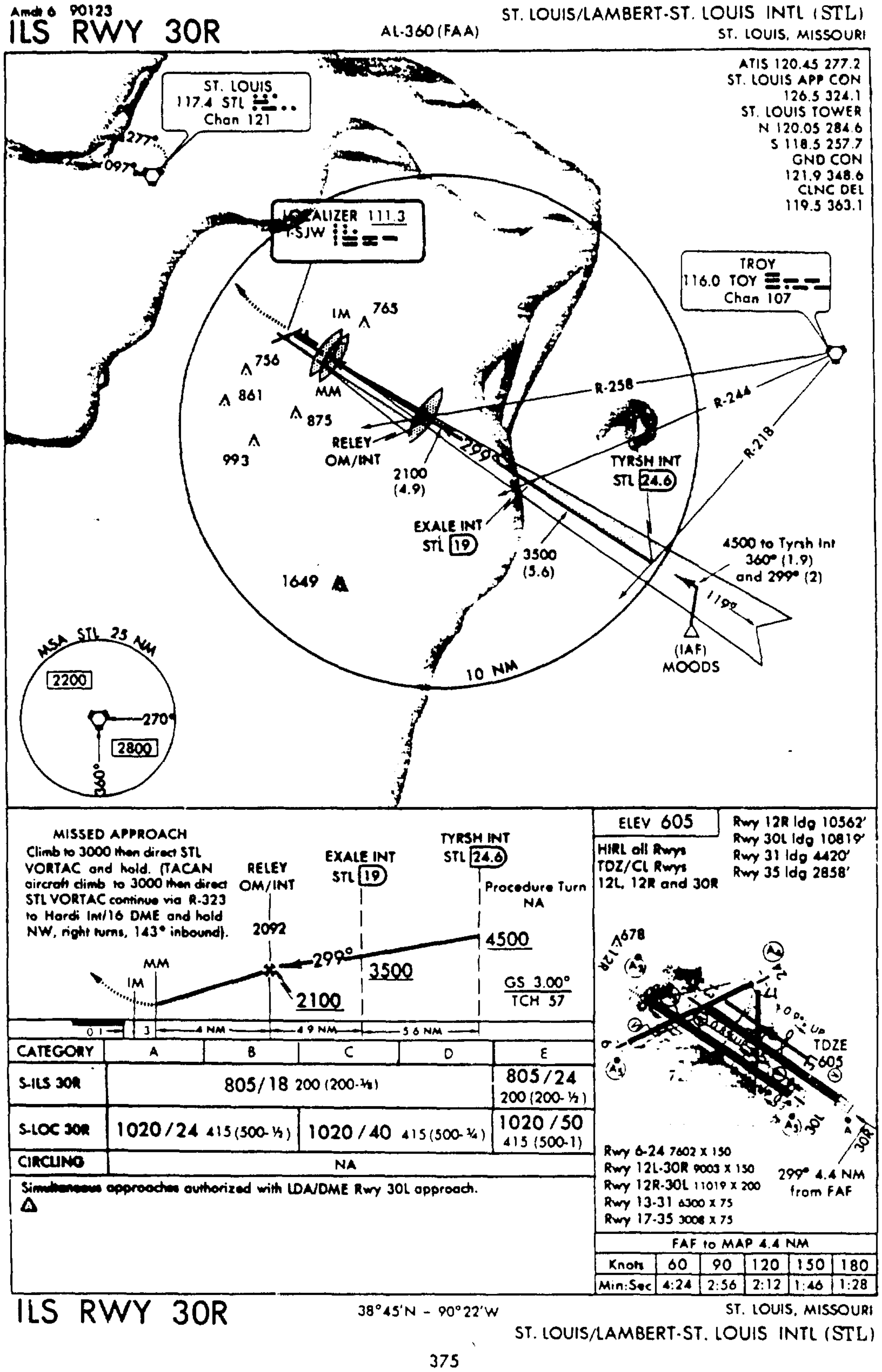


FIGURE 5. STL CHARTED ILS RWY 30R APPROACH PLATE

378

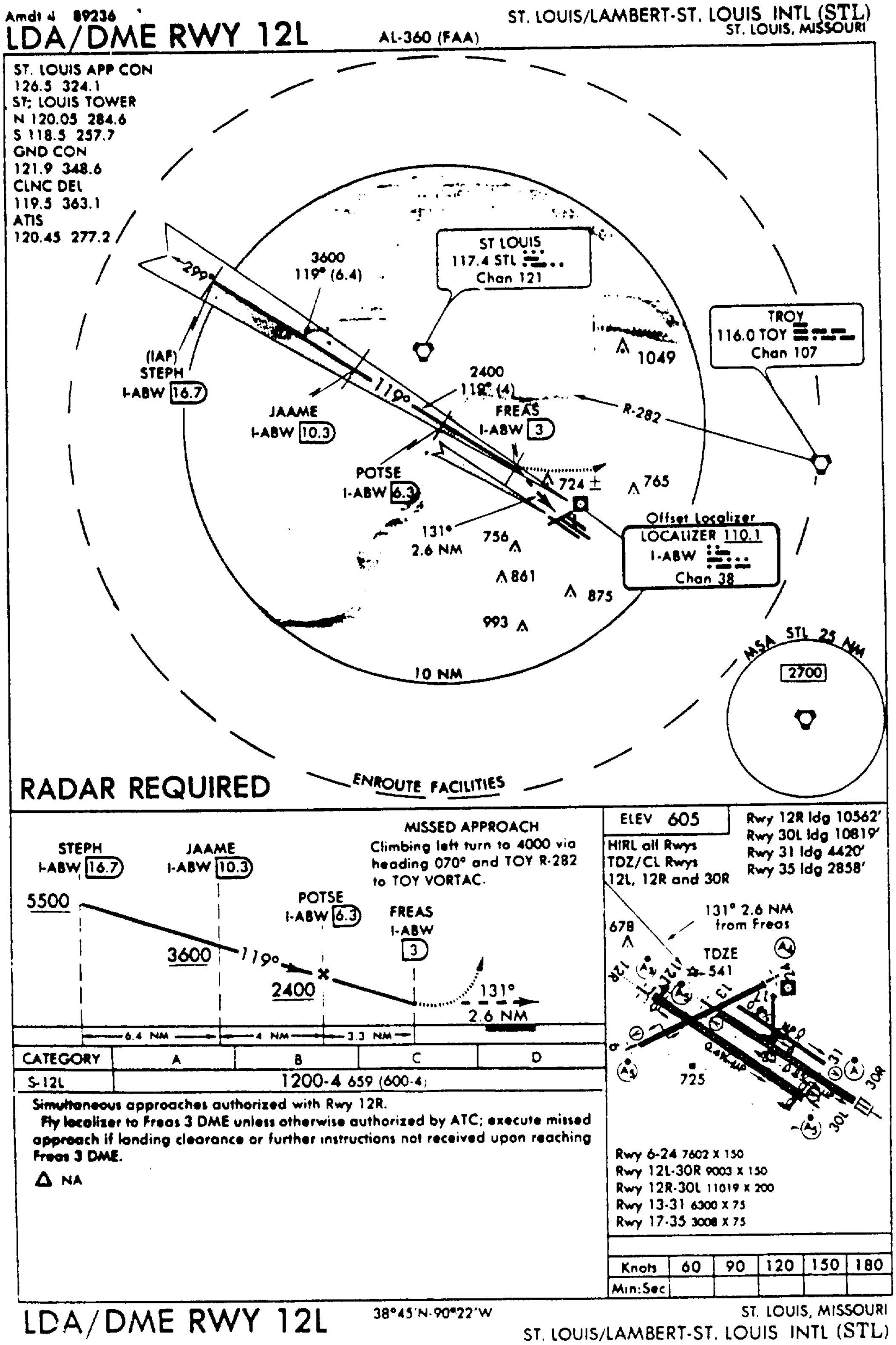


FIGURE 6. STL CHARTED LDA RWY 12L APPROACH PLATE

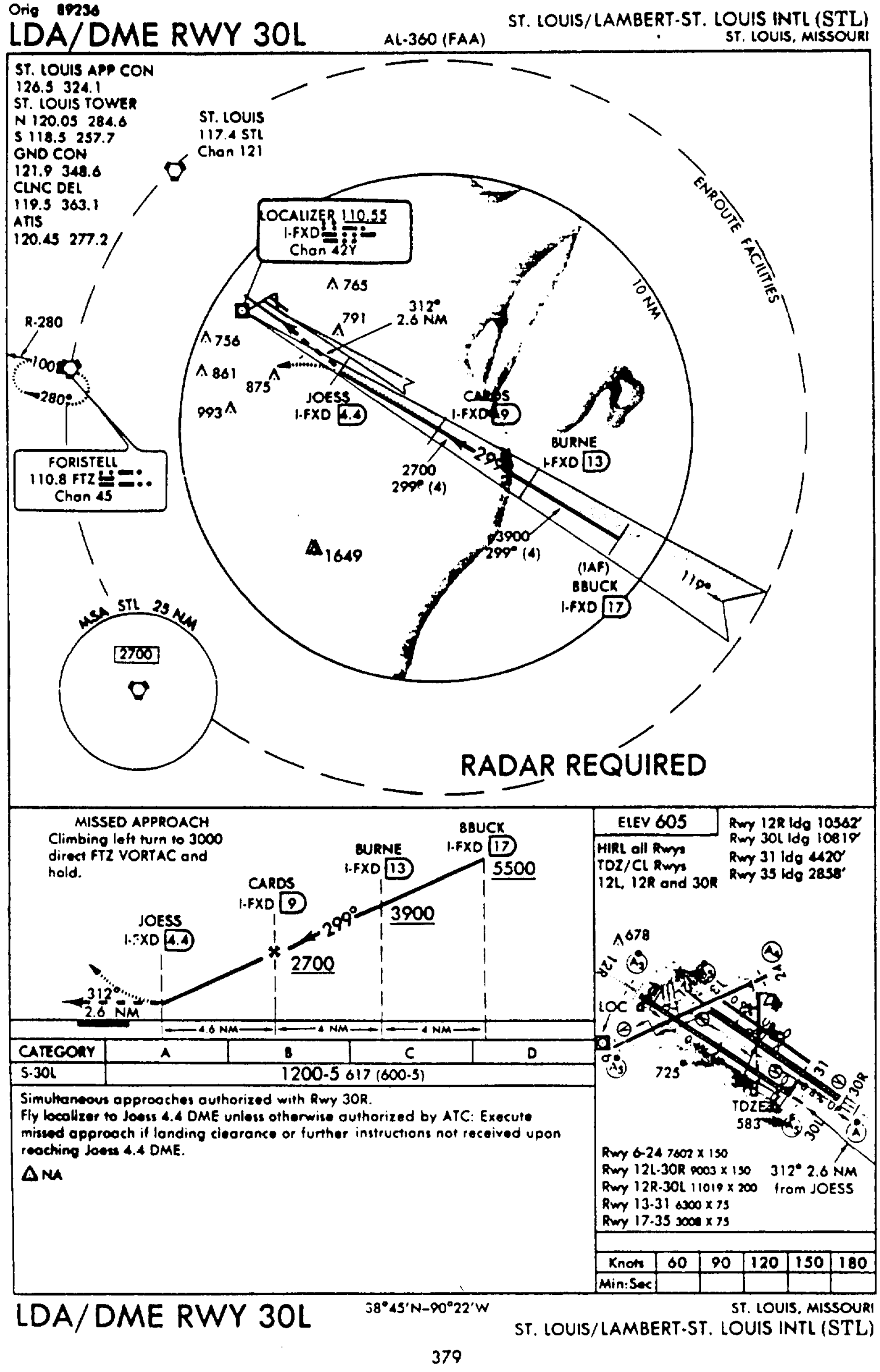


FIGURE 7. STL CHARTED LDA RWY 30L APPROACH PLATE

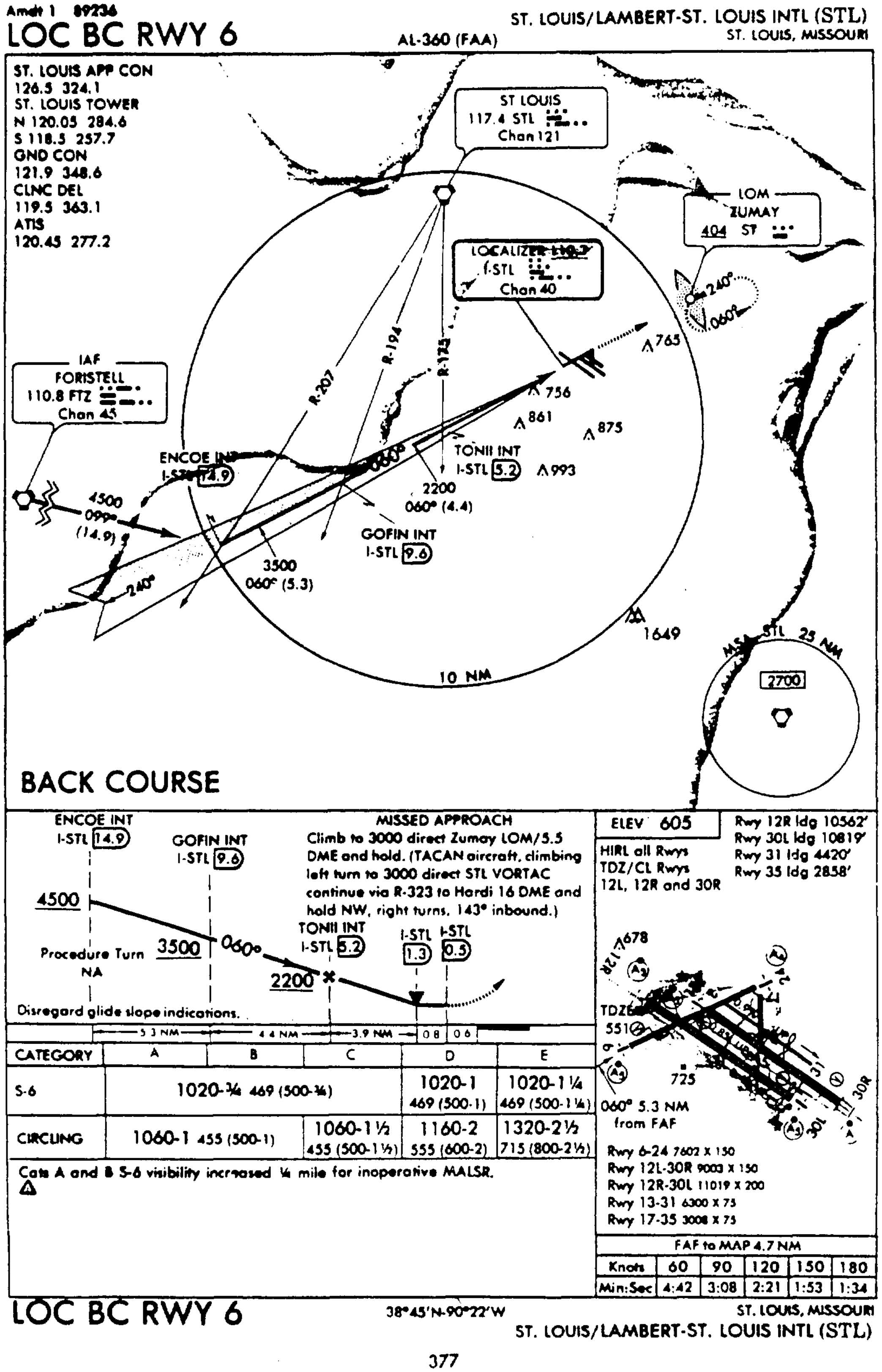


FIGURE 8. STL CHARTED LOC BC RWY 06 APPROACH PLATE

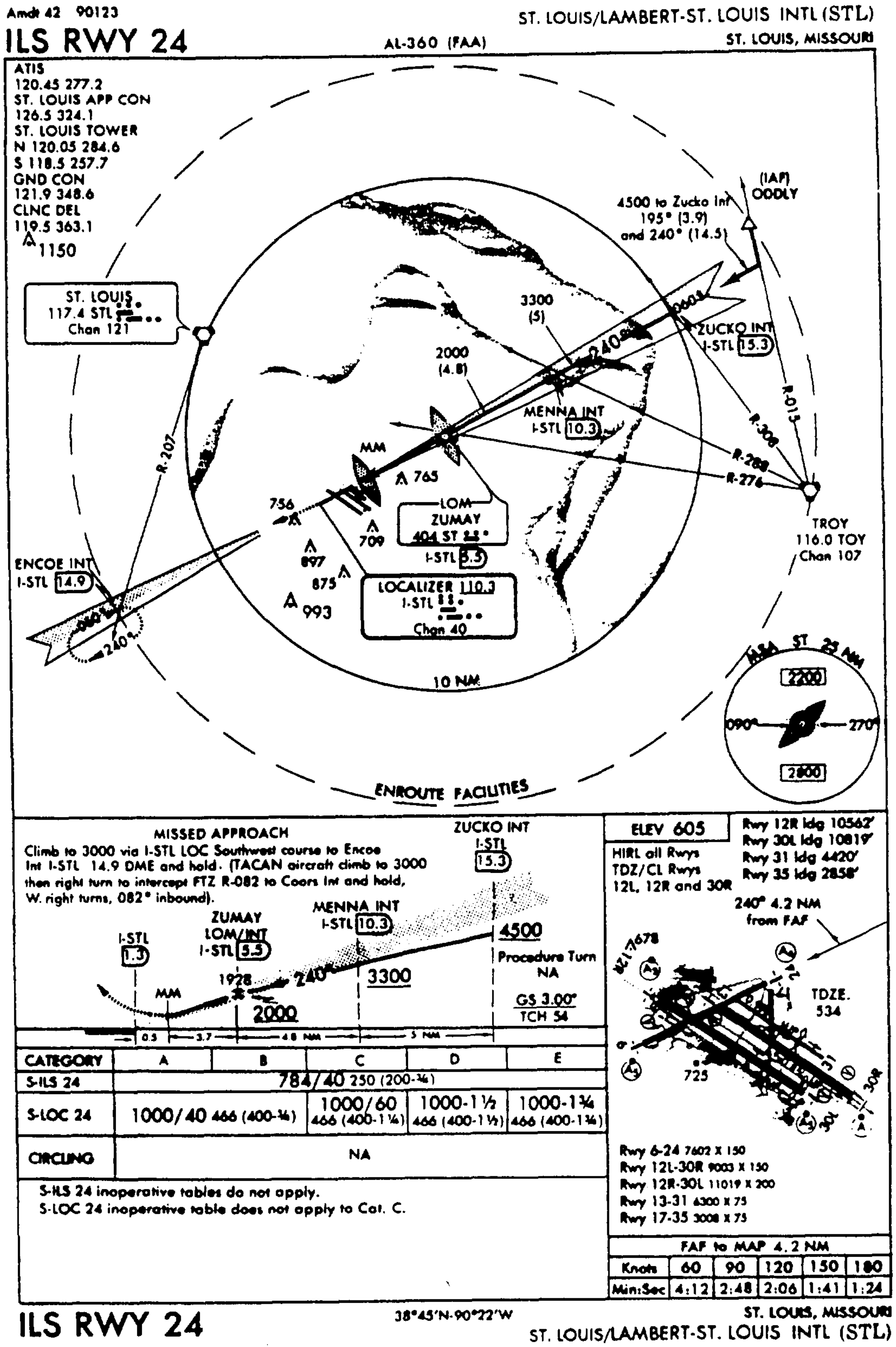
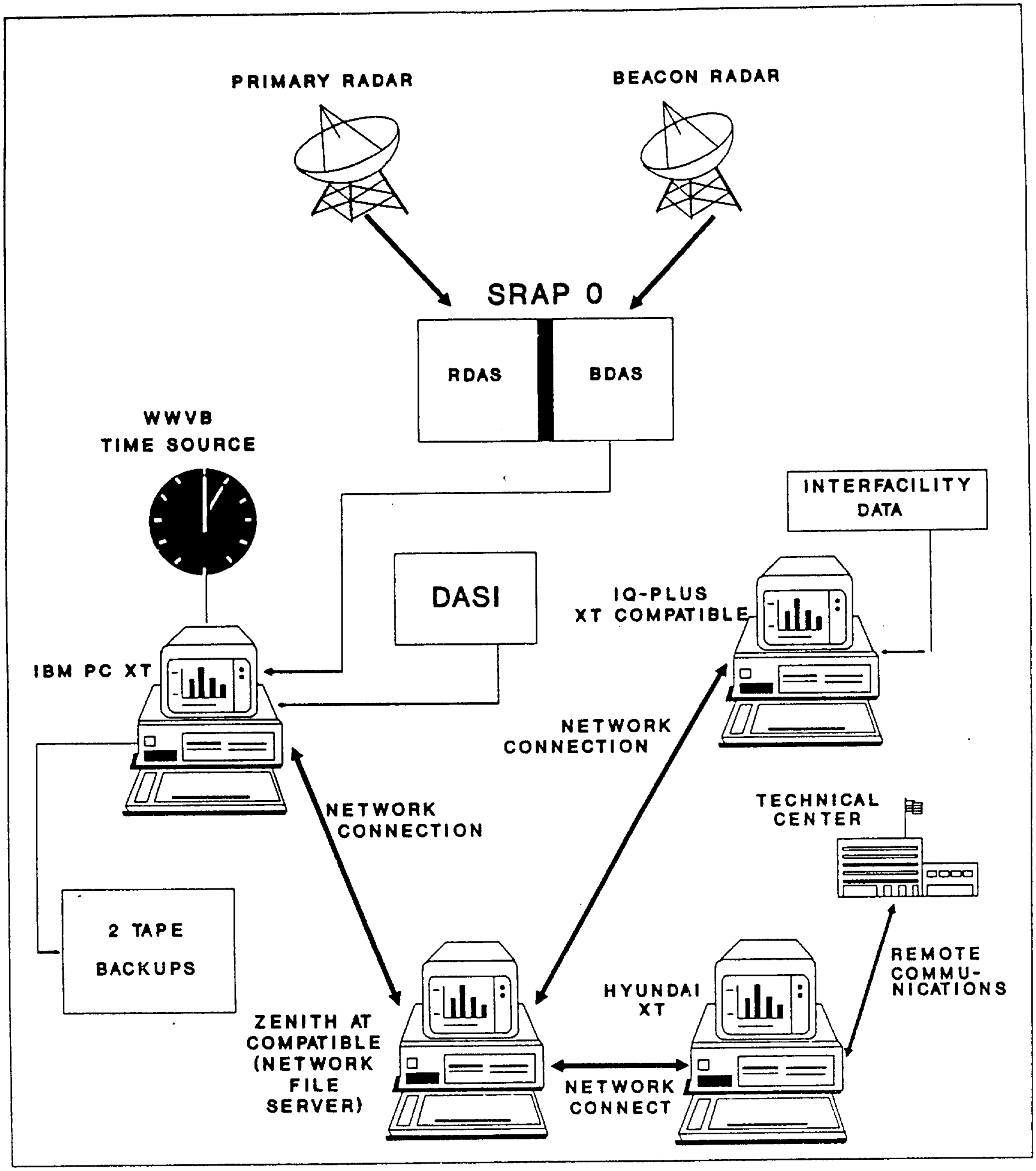


FIGURE 9. STL CHARTED ILS RWY 24 APPROACH PLATE



DUALSRAP DATA COLLECTION SYSTEM
(as used at St. Louis)

FIGURE 10. DUALSRAP DATA COLLECTION SYSTEM

a. SRAP.

b. Interface Card Cage containing:

   1. Two SRAP to PC interface cards.
   2. Sensor Interface to PC interface card.
   3. Digital Altimeter Setting Indicator (DASI) interface card.

c. Interfacility Data System Microprocessor (IDSM) Interface Unit and cables.

d. WWVB Time Code Receiver and Antenna.

e. IBM PC XT Computer System with Expansion Chassis.

f. Zenith Z-248 Computer System.

g. IQ-Plus IBM XT Compatible Computer.

h. Hyundai SAM2001 IBM XT compatible computer.

i. Two Mountain Filesafe Series 7300 150 MB Tape Backups.

j. VLR-466 Voice Logging Recorder.

h. American Power Conversion 1200VX Uninterruptible Power Supply.

4.1.1.1 SRAP.

The project SRAP accepted analog signals from the ASR-8 and ATCBI-5 and converted the data into digital target reports used by the Automated Radar Terminal System (ARTS) IIIA processor. The SRAP consisted of a Radar Data Acquisition Subsystem (RDAS) and a Beacon Data Acquisition Subsystem (BDAS). The RDAS provided detection of range and azimuth of aircraft targets and weather. The BDAS provided for the detection and reporting of the range, azimuth, altitude, and identity of transponder equipped aircraft. The BDAS also received data from the RDAS in order to perform radar/beacon target correlation. Data were output from the SRAP via the Peripheral Interface Module (PIM) in the form of either a one, two, or three 32-bit word message. SRAP output consisted of the following message types:

Report Type	Description
1	Radar only reports (2 words) Used ASR radar video
2	Beacon only/radar reinforced beacon reports (3 words) Used ATCBI or ATCBI/ASR radar videos
3	Alarms (1 word) Reported SRAP processing errors
4	Sector mark (1 word) Message output every 11.25° of radar scan

4.1.1.2 SRAP/XT Interface.

FAA Technical Center personnel designed and fabricated a SRAP interface and control card set that served as an interface between a PC and the SRAP. SRAP data were obtained from the PIM using two 50-conductor flat cables. The interface card converted 32-bit SRAP message words into the IBM PC 8-bit word format. The card read each complete SRAP message as quickly as the SRAP could send it (one, two, three words). Each message was broken down in two, four, six, or twelve 8-bit bytes. An interrupt was then sent by the card to notify the PC of data ready to send. The interface card supported the four previously defined SRAP message types. The interface permitted simultaneous collection of data from two separate RDAS/BDAS subsystems (SRAP0 and SRAP1). These subsystems can be connected to the same or different radar sources. It provided the following preprocessing functions for each channel:

a. Automatic synchronization with the SRAP data by sector marks.

b. Identification of each SRAP data report type.

c. Filtering by sector for report types 1 and 2 above.

d. Input, reformatting, and storage of a complete SRAP report.

e. Hardware interrupt to XT to request report transfer.

f. Transmission of report to XT via an Input/Output (I/O) channel on a byte basis.

The interface incorporated azimuth filtering of the radar and beacon only/radar reinforced messages based on sector mark. Board-mounted DIP switches were used to select both a start and stop sector. These switches were set prior to each test to restrict collected sectors to those actually used by the aircraft during approach and landing. In this way the amount of unwanted data were minimized, thereby reducing the XT workload and the amount of collected data. The sector switches could be changed during a test without stopping collection. In this way changing approach configurations were accommodated while minimizing the amount of missed data.

4.1.1.3 DASI/XT Interface.

DASI data were collected by the DASI interface card. The IBM PC polled the DASI interface card every 4.7 seconds to see if data were present.

4.1.1.4 IDSM Interface.

STL interfacility data were collected via the Landrum and Brown ARTS IDentification Data Acquisition System (ID-DAS). The ID-DAS interface consisted of a Persyst multiport serial coprocessor board, a distributed communications processor capable of running independently of the Host PC, and the ID-DAS Fortran software.

4.1.1.5 Computer Equipment.

The computers used for data collection were standard IBM XT or AT Compatible systems with a number of add-on cards. The IBM XT, IQ-PLUS, Hyundai, and Zenith Z-248 were located at the STL TRACON. Two dedicated phone lines at the site were required for remote monitoring and control of data collection.

The IBM XT ran the DUALSRAP program that collected, time-tagged, and stored SRAP and DASI data. Add-on cards included a 80286/80287 Turbo card with onboard memory cache for added processing power, a 2 Mb expanded memory board, a Local Area Network (LAN) card, and a 2400 baud modem.

The Zenith Z-248 AT compatible functioned as a nondedicated network file server. It allowed all computers to access a common network disk. The Zenith had a 600 Mb drive that saved SRAP and DASI data after the day's data collection was finished. The Zenith also included software to allow on-site reduction and plotting of collected tracks while the XT continued to collect data. Add-on cards included 2.5 Mb of extended memory, a 2400 baud modem, and a LAN card.

The IQ-PLUS IBM XT compatible was set up to collect interfacility data. Add-on cards were the Emulex DCP board, a LAN card, and a 2400 baud modem.

The Hyundai SAM2001 IBM XT compatible was configured with communications software that enabled it to control the other computers on the network. This allowed FAA Technical Center personnel to call up the Hyundai via modem to monitor and control the IBM XT, the IQ-PLUS and the Zenith Z-248. Add-on cards were a 2400 baud modem card and a LAN card.

A PC located at the FAA Technical Center was used to collect the weather data for STL.

4.1.2 Data Collection Interfaces.

Two types of data were collected. Aircraft track data were collected via the DUALSRAP System. Weather and pilot/controller communications were collected by separate systems. Detailed descriptions of the data files are contained in appendix A.

4.1.2.1 DUALSRAP Hardware Interface.

The DUALSRAP Data Collection System, shown in figure 10 and described in section 4.1.2, interfaced with the following hardware:

a. ASR-8 and ATCBI-5 search and beacon radar, via a SRAP
b. IDSM
c. DASI
d. WWVB Reference Time.

Aircraft position was determined from target replies provided by the STL TRACON ASR-8 and ATCBI-5. Radar videos and triggers were received by a project-supplied SRAP from a feed on the TRACON radar distribution amplifiers; the project used the same raw radar data used by the operational system. The SRAP converted the

radar analog data into digital processed information for the ARTS IIIA processor. To minimize impact to the St. Louis ARTS, the project obtained a surplus SRAP from the FAA Depot in Oklahoma City for stand-alone use. This SRAP's analog front end and digital parameter settings were brought up to certification standards by STL Airways Facilities personnel.

The STL interfacility data were collected by teeing off of the feeds between the ARTS Peripheral Adapter Module (PAM) and the interfacility modems. These data provided flight plan information regarding flights in the National Airspace System (NAS). This was automatically reduced to provide each flight's beacon code, aircraft ID, aircraft type, approach fix, and altitude at the fix. The information was transmitted between the STL TRACON and the Kansas City Air Route Traffic Control Center (ARTCC)(ZCK). For this data collection, only STL arrival information was extracted and stored to disk; departures and overflight data were ignored.

DASI data were collected at STL. T' DASI provided local digitized barometric pressure.

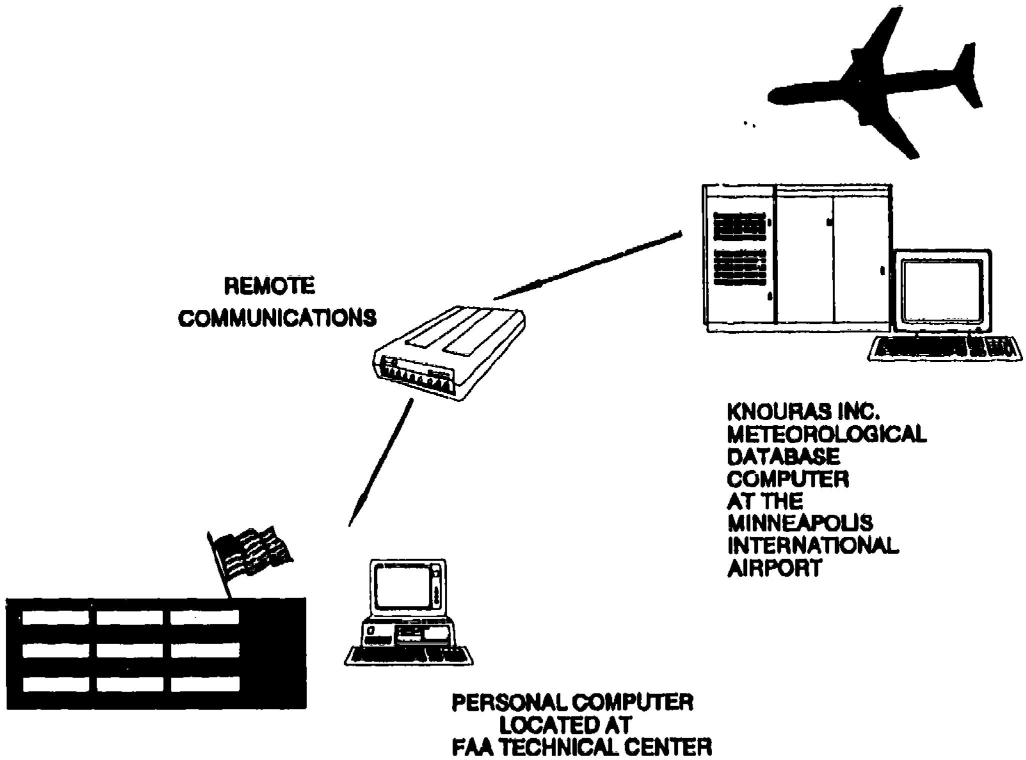
The National Bureau of Standards (NBS) WWVB broadcast station located in Fort Collins, Colorado, was used as the data collection's reference time source. WWVB time was received and processed by a commercially available unit with an accurate internal clock. This provided a stable reference at the site when radio reception was poor. This time was used at the start of each data collection session to synchronize the PC internal real-time clock (Disk Operating System (DOS) time). The DOS time was then used to time-stamp each of the SRAP sector reports recorded to disk.

4.1.2.2 Additional Interfaces.

Data obtained from these sources were not used by DUALSRAP during the data collection process. These data were used in the data extraction and reduction processes.

The STL National Weather Service (NWS) meteorological reports were collected once a day via modem from the Kavouras, Inc. meteorological database computer located at the Minneapolis International Airport (shown in figure 11). Surface Observation Reports (SA) were normally available on an hourly basis, with Special Reports (SP) given more frequently when warranted by rapidly changing weather conditions. A full report consisted of cloud heights and coverage, visibility, weather, temperature, dewpoint, wind direction and speed, altimeter, and remarks. Remarks were conditions considered significant to aviation such as runway visibility, cloud types, icing conditions, etc.

Voice recordings of pilot/air traffic controller communications for approach control, local control, and the Automatic Terminal Information Service (ATIS) channel were made on a 4-channel audio recorder interfaced with the Granger Link Microwave System. An accurate date and time-of-day stamp was integrated with each recorded channel. This allowed searches for specific portions of the recordings on a time basis.



WEATHER DATA COLLECTION SYSTEM

(as used at FAA Technical Center)

FIGURE 11. WEATHER DATA COLLECTION SYSTEM

4.2 DATA COLLECTION SYSTEM SOFTWARE.

4.2.1 SRAP Data Collection Software.

An ACD-340 written 8088 assembly language program collected, time-stamped, and stored SRAP and DASI data to disk. Assembly language was used for maximum speed and hardware control. The program consisted of foreground and background processes. Since DASI data collection had a relatively low data rate, the background process polled the DASI to PC interface card every 4 seconds. SRAP data collection had a much higher data rate and was handled by the foreground routine using hardware interrupts. Collected SRAP and DASI data were saved into memory buffers. These buffers were dumped to disk when full.

The DUALSRAP system software was modified to allow greater flexibility for remote operation. The options that defined the system configuration for a given session included:

a. Synchronization of DOS time with WWVB time at start of data collection (synchronized for STL).

b. Range filtering (4, 8, 16, 32, or 64 miles) of collected targets with respect to radar collection (16 miles for STL).

c. Collection of DASI sensor data (collected for STL).

d. SRAP(s) to be used (SRAP 0 for STL).

e. Collection of radar-only messages for each SRAP; however, these messages had limited use and required considerable storage space and, therefore, were not collected for STL.

f. Termination of data collection at a preset time each day (2200 hours for STL).

g. Specification of Start and Stop Sector Marks using board-mounted switches.

4.2.2 Interfacility Data Collection Software.

An executable Fortran program collected and stored interfacility data. The program's configuration had to be set up each time data collection was started. The ID-DAS provided the ability to execute the collection software via a batch command. The batch command specified a redirected input file with the necessary responses needed to initialize and configure the software. These options were set as:

a. Processing mode = Arrivals only for STL (options were all operations, arrivals, departures, not overflights).

b. Included all aircraft ID's for STL.

c. All ARTS interfacility messages, pertinent to ID-DAS, were copied to a buffer file.

d. Start and Stop times were specified for STL (data collection began immediately upon program execution and stopped at 2200 hours).

e. Default output filename set for STL (Imddhhmm.AOL - m = month, dd = day, hh = hour, and mm = minute).

4.2.3 Weather Data Collection Software.

PC Weather was a telecommunications program which accessed the Kavouras Inc. meteorological database. The software was set up to call up and log onto the Kavouras database, request the 30 previous SA reports, save the reports to disk, and log off the system. Since PC Weather was intended primarily to be used as an interactive program, it was necessary to use Extended Batch Language (EBL) to execute the program unattended. EBL was used to execute the following actions in the weather data collection program:

a. Dial the weather database.

b. Enter the User Name and Password to gain access to the system.

c. Send the command "SA/STL RPTS=30," which requested the last 30 SA reports for STL.

d. Request that the weather data be saved to disk.

e. Log off the database and then exit the data collection program.

4.2.4 Data Collection Support Software.

Various off-the-shelf software packages were used to support the STL data collection effort. The support software were supplied by Mountain Computer, Inc., Fox Software, Inc., Seaware Corporation, Novell Incorporated, Dynamic Microprocessor Associates, Inc., and Brightwork Development Inc.

4.2.4.1 Autorun.

Autorun is a program supplied with the Mountain Filesafe Tape Backup software. The program executed appointments based on the DOS time and date of a computer. Autorun was used to start the SRAP and interfacility data collection each day.

4.2.4.2 Foxbase.

Foxbase +2.10 is a database management program. When daily data collection was started, a Foxbase language program was executed. This program created DOS batch files that were used to rename data collection files, to set the attributes of those files, and to delete the files at various stages of the data collection. For a more detailed description of these batch files refer to appendix D of this report.

4.2.4.3 EBL.

EBL is a command programming language. The "Keyboard Stack" feature of EBL was used for weather data collection. The "Keyboard Stack" allowed for answering questions within programs without operator intervention. Data placed in the "stack" was seen by the data collection program during execution as operator input.

4.2.4.4 Novell NetWare.

NetWare was used to set up the local area network for the IBM XT and the Zenith Z-248 computers at STL with the Z-248 being used as the network server.

4.2.4.5 pcAnywhere.

pcAnywhere is a remote access software package that provided for remote monitoring and operation of the project computers via modem from the FAA Technical Center.

4.2.4.6 NETremote.

NETremote+ is a communications program that permits a single computer (Hyundai) in a LAN to have control over any other computer in the LAN. This allowed FAA Technical Center personnel to have remote access to any project computer on the network through one phone line.

4.3 DATA COLLECTION PROCEDURES.

After the data collection procedures were established, it was not necessary to have ACD-340 personnel on-site. Data collection was monitored and operated by ACD-340 personnel at the FAA Technical Center.

4.3.1 SRAP Data Collection Procedures.

The SRAP and DASI data collection process consisted of various programs invoked by a batch file. The batch file was started on the IBM XT each day at 0600 hours (Central time). The batch file initiated the following procedures:

a. Created DOS batch files that were later executed during data collection to rename, set attributes of, and delete data files.

b. Started the DUALSRAP data collection program, this program ran from the time it was started until 2200 hours local time (Central time zone).

c. After the data collection program terminated, the names of the SRAP, DASI, and message data files were changed to reflect the month, day, and hour of that day's data collection. The IBM XT logged onto the network and the day's data were then saved to the network drive.

d. Primary and secondary tape backups of the day's data files were performed.

e. If the day's data were successfully copied to the network drive, then the day's data files were deleted from the XT's hard drive.

f. Reset the DOS clock to WWVB time and rebooted the IBM XT.

If any problems occurred during data collection and the XT had to be rebooted, the data collection batch file could be restarted manually by on-site personnel or remotely by FAA Technical Center personnel. For more details on the SRAP data collection procedures refer to appendix D of this report.

4.3.2 Interfacility Data Collection Procedures.

The Landrum and Brown ARTS ID-DAS was invoked by a batch file. The batch file was started on the IQ-PLUS XT PC compatible each day at 0500 hours (Central time) by an appointment scheduling program, Autorun. Interfacility data collection started 1 hour before SRAP data collection. The earlier start time accounted for the up to 1 hour time difference between the receipt of interfacility data for an aircraft and the aircraft's arrival time at the airport. The batch file initiated the following procedures:

a. Checked for the existence of old data files in the interfacility data subdirectory on the IQ-PLUS hard drive. If any files were present they were deleted.

b. Set up configuration and started execution of the interfacility data collection program. This program ran from when it was started until 2200 hours (Central time).

c. Backed up the day's data to hard disk and to the network drive. The interfacility data saved on the network drive was backed up on tape at the same time as the SRAP data files.

If any problems occurred during data collection necessitating a reboot of the IQ-PLUS, interfacility data collection may be restarted manually either remotely or by on-site personnel. For more detail on interfacility data collection procedures refer to appendix D.

4.3.3 Weather Data Collection Procedures.

The weather data collection process was invoked by a batch file. The batch file was started on an IBM compatible computer, located at the FAA Technical Center, each day at 2350 hours (Eastern time) by Autorun. The batch file initiated the following procedures:

a. Checked for the existence of old data files in the weather data subdirectory on the computer's hard drive. If any files were present they were deleted.

b. Set up configuration and started execution of the weather data collection program.

c. Backed up the weather data to the PC's hard drive.

5. DATA PROCESSING.

The raw STL data were processed at the FAA Technical Center to reduce it to a form suitable for analysis by ACD-340 and AVN-540. Data files generated in the collection and reduction processes are described in detail in appendix A. The data extraction and reduction processes are outlined in figure 12.

5.1 DATA EXTRACTION AND REDUCTION.

5.1.1 Data Unpacking.

Subsequent to data collection but prior to data analysis, track data were extracted from the raw SRAP and interfacility files and merged into a database consisting of parallel approaches. The extraction procedure, unpacking, was the process whereby radar data, recorded in a binary format for purposes of space and efficiency, was converted to a format compatible with the analysis environment. The unpacking process consisted of the following:

a. Valid surveillance messages were extracted from the raw SRAP file; both SRAP and interfacility data were converted to engineering units, then written to fixed format files.

b. Data were sorted into individual aircraft track files according to beacon code, aircraft tracks with a sufficient number of scans were identified, and the runway being approached was determined for each track.

c. SRAP and interfacility data were cross-referenced to obtain the aircraft ID and the aircraft type for each track.

d. One record for each track was appended to the Master database. The raw track files were placed into a session subdirectory, where a session was 1 day of the collection period. For a description of the software used during unpacking, see appendix B.

5.1.2 Parrot Statistics.

The Parrot Statistics test was executed on the unpacked SRAP data to assist in the calculation of the radar range and azimuth biases for a session. This test was a series of programs that collected, unpacked, analyzed, and produced a statistical report on the quantity and quality of transponder data. The transponder data, collected continuously during each session, was received from the STL radar Parrot transponder located approximately 7 miles from the radar antenna. There was a time delay in the Parrot's response to an interrogation, causing the indicated range to appear to be approximately 45 nautical miles (nmi). The report had values, based on the total number of Parrot returns, for the mean and standard deviation of both range and azimuth, and the Azimuth Change Pulse (ACP) skewness and kurtosis of the azimuth. The report (figure 13) was compared with previous reports to determine if there had been any change in the radar range and azimuth mean values. There were no significant changes in the reported range and azimuth values during the data collection period. Any significant change of these values would have entailed adjustment of the range and azimuth bias values for individual sessions. The consistency of the reported

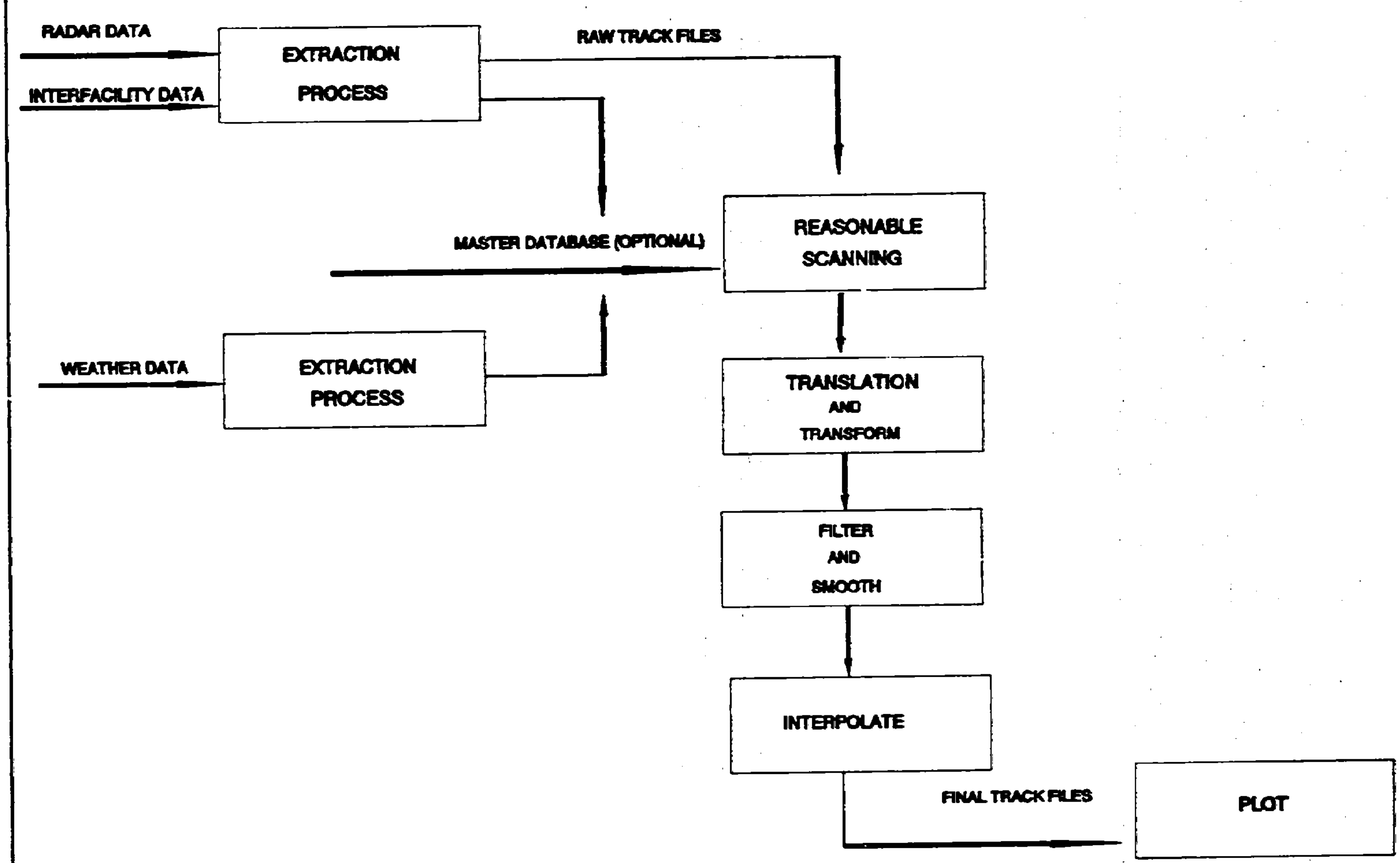


FIGURE 12. DATA EXTRACTION AND REDUCTION PROCESS

range and azimuth values for the Parrot transponder confirmed that the ATCBI-5 range and azimuth biases remained constant during the data collection period. These biases were not calculated using the Parrot's latitude and longitude values, rather, they were determined empirically from reduced track data to yield reasonable alignment of the approach paths to the corresponding runways. Once the bias values were set, they were removed from the track data during the translation to runway origin.

5.1.3 Data Reduction.

The reduction process used the "raw" or unfiltered track files created by the unpacking process and performed the following operations:

a. Individual track data files were checked for reasonableness; multiple scans were deleted, altitudes were added or corrected as needed, time gaps in data were identified, and pre- and post-gap data were checked to see if they were from the same track.

b. Data were converted from (range, azimuth, altitude) to cartesian (x, y, z) coordinates. Range and azimuth biases were removed from the track data.

c. Data were filtered and smoothed using Lincoln Laboratory developed algorithms.

d. Interpolated data points were calculated at 0.15 nmi increments along the extended runway centerline.

The final reduced track file consisted of reports at 0.15 nmi increments along the extended runway centerline. Each track file record contained: Time (the time of day in hours, minutes, and seconds), X (distance from the runway threshold along the extended runway centerline), Y (deviation from extended runway centerline), and Z (altitude above sea level). X, Y, and Z were expressed in nmi; the conversion factor used was 6076 feet/nmi. The file was assembled in reverse time order; i.e., the first record in the file represented the touchdown point or the distance closest to touchdown. Each successive record was an additional 0.15 nmi from touchdown in the +X direction. These track files were then individually plotted and sent to AVN-540 for further analysis. For a description of the software used during reduction, see appendix B.

All track files for each session were plotted as a group on one 2-dimensional x,y graph where x represents distance to runway touchdown and y represents deviation about extended runway centerline. An example of this type of plot is shown in figure 14. The plots were identified by the session (test) number, runway designation, and the number of track files plotted. A grid in both axes was superimposed on the plot so that distances could be more easily judged. The x scale was from touchdown to 15 nmi out; the y scale was plus or minus 1 nmi.

5.1.4 Master Database.

A Master database consisting of pertinent information about each track and weather observations at the time of data collection was produced through the unpacking process. Note: the Master database does not contain any radar data.

Radar Statistics using C:\STL\UNPACK\S9090600.DBF

```
>>>                                                                        <<

              Total number of samples is 12256
              Mean value of RANGE is 45.183 nmi (274263 ft)
              Mean value of ACP count is 3144.37 (276.36 deg)
              Standard Deviation of RANGE is 0.008 nmi (46.7 ft)
              Standard Deviation of ACP is 1.587  (0.139 deg/2.43 mr)
                  or 667.6 ft @ 45.183 nmi
              The Skewness of ACP is 0.272
              The Kurtosis of ACP is 6.908
              Range of ACP's is from 3132 to 3161
                  or 275.27 to 277.82 deg


ACP                                                                           CNT
3132                                                                            3
3133                                                                            0
3134                                                                            3
3135                                                                            1
3136                                                                            4
3137                                                                            6
3138                                                                            6
3139                                                                           17
3140 *                                                                         37
3141 *****                                                                    225
3142 **********************                                                   972
3143 **********************************************                           ***
3144 **************************************************************************
3145 *********************************************************************    ***
3146 *****************************************                                ***
3147 ***************                                                          648
3148 ***                                                                      141
3149 *                                                                         26
3150                                                                            8
3151                                                                            8
3152                                                                            2
3153                                                                            1
3154                                                                            0
3155                                                                            0
3156                                                                            0
3157                                                                            2
3158                                                                            3
3159                                                                            2
3160                                                                            0
3161                                                                            2
     +-----------------------------------|-----------------------------------+
     0
```

FIGURE 13.   RADAR STATISTICS FOR PARROT TRANSPONDER

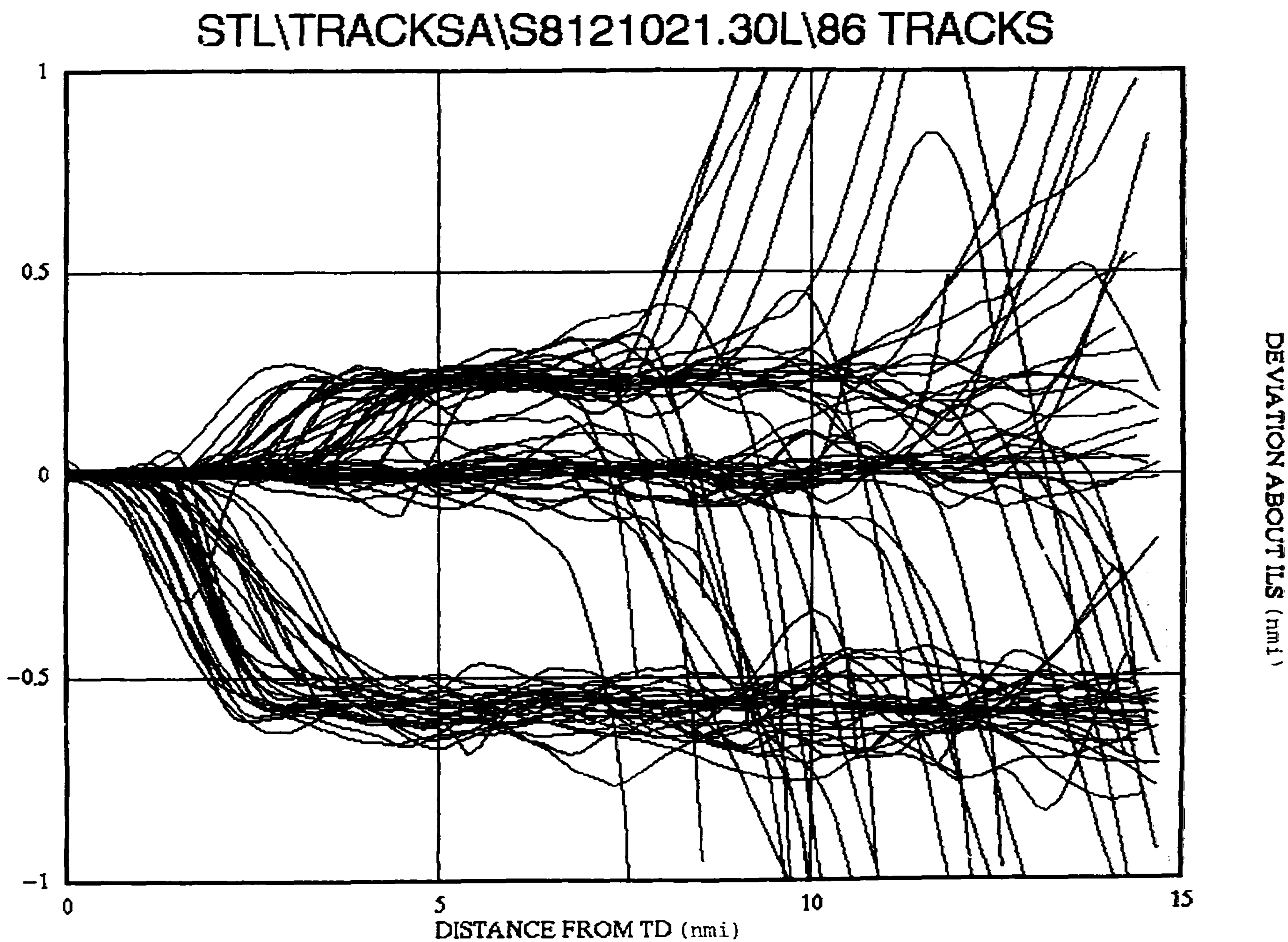


FIGURE 14. EXAMPLE SESSION TRACKS PLOT

This database was used to identify tracks for conditions that need to be analyzed. For a more detailed description of the Master database fields, see appendix C.

5.2 DELIVERABLES.

The requested track data and their plots were delivered to AVN-540. The format for sending the data was floppy disks. The floppy disks included the final track files for each session and the Master database. Documentation explaining the data were also sent along with the plots created for each session.

6. DISCUSSION.

6.1 DATA REDUCTION RESPONSIBILITIES.

The Engineering, Research, And Development Service, ACD-340, was tasked to collect and reduce track data for aircraft conducting visual approaches to STL runways 12L and 12R, 30L and 30R, 06 and 12L, and 24 and 30L. These data will be used by AVN-540 to justify existing procedures and/or specify new procedures for these approach operations. Since AVN-540 had expressed the need to conduct their own comprehensive analysis of these data, ACD-340 performed only a limited analysis to determine if the processed data were reasonable. ACD-340's primary concerns were to determine how well the data represented what really happened. This section will, therefore, address the primary causes of error found in the collected data and steps taken by ACD-340 to improve the quality of the deliverables.

6.2 DATA FIDELITY.

The data reduction process (see section 5) produced a file of position information in t, x, y, and z for each recorded track where t was time of day, x was the distance from the runway threshold along the extended runway centerline, y was the perpendicular distance from the extended runway centerline, and z was the altitude above mean sea level (m.s.l.). These data were filtered, smoothed (see appendix A and Thomas, 1990), and interpolated to give a data point at each 0.15 nmi increment along the extended runway centerline. This was done to facilitate the calculation of statistics at specific fixed distances from the runway threshold. In addition, since the data were collected via an ATC ASR-8, range and azimuth biases were removed as much as possible, then the data were translated from range, azimuth, and altitude having an origin at the radar antenna, to x, y, and z having an origin at the runway threshold. The final result was a collection of sessions. A session consisted of the reduced data files for all the tracks collected in a day. All tracks for a session were plotted on a single graph; they were also subjected to a simple statistical analysis producing average and standard deviations about the extended runway centerline at increments of 0.15 nmi away from runway threshold. Examples of these plots can be found in the Data Reduction section. Details of the procedures used to remove radar data biases can also be found in that section.

Since we did not have any independent devices with which to observe each track, such as a second radar, the only way to judge the reasonableness of the positional information recorded was to consider the data just prior to aircraft

touchdown. It was known that every aircraft landed on the runway surface. However, the plots and statistics show that the data had some variance about the runway centerline just prior to landing. On average for example, the standard deviation at 0.45 nmi from touchdown was approximately 43 feet. This meant that the vast majority (but not all) of the recorded data indicated that the aircraft touched down on the runway surface. In comparison, the average standard deviation for STL was considerably smaller than the 140-foot deviation found during the San Francisco International Airport (SFO) data collection (Richards, 1991). The good data fidelity can most likely be attributed to the favorable siting of the STL radar and minimal ground clutter. The STL runways are all within 1.5 nmi of the radar compared to over 8 miles between the SFO runways and the radar. However, new problems were encountered in the data reduction processing due to the closeness of the STL radar, and difficulties experienced with the interfacility data collection. These problems are discussed in more detail the following sections.

5.2.1 Track Extraction Problems.

It was found that the tracks were particularly difficult to smooth with high fidelity near their terminus (Thomas, 1990). Ground clutter produced some erroneous radar replies from the ASR-8 and lowered the occurrence of primary/beacon radar reinforcement with the corresponding ATCBI-5 surveillance report. When coupled with the relatively low 4.7 second scan rate, one or more questionable or missing surveillance reports close to touchdown could significantly skew the smooth estimate of the track at its terminus, making the aircraft appear to have missed the runway by a small amount. Fortunately, most of the track files displayed good radar data down to landing. Track data files with problematic radar data were found by displaying an entire session on a single plot, then visually picking out the deviant tracks. These tracks were examined manually; surveillance reports having more than a reasonable amount of deviation (approximately 5 sigma) at touchdown were removed leaving a data gap. This data gap would later be "refilled" by the smoothing process.

It was found in previous data collections (FAA Technical Center, Chicago O'Hare Internation Airport (ORD), and SFO) that operational radars typically do not report targets near the ground. Most sites set equipment parameters to cutoff radar coverage when the range is less than about 1 nmi. This normally avoids artifacts such as "ring around"; it also eliminates arriving and departing flights that will be below a few hundred feet altitude within 1 nmi. However, at STL, a significant number of aircraft were "seen" up to and well after touchdown. This "extended" radar coverage, coupled with a malfunction in the interfacility data collection, created a new reduction problem. When an arriving aircraft and a departing aircraft having the same beacon code were active within the same 40-minute "window," the track file would erroneously contain radar data for both aircraft. In previous data collections (ORD and SFO), accurate flight termination times were obtained from interfacility data (ARTS Terminate Beacon (TB) reports). At STL, only the hand-off time (ARTCC to TRACON) could be obtained from the collected interfacility data. This required a 40-minute window to be used by the reduction software to account for the time between hand-off and landing. Files having this problem were identified by their relatively large size (> 10K bytes) and the erroneous data removed manually. This was a labor intensive, but very important step, in assuring track quality.

Another factor taken into consideration were measurement errors in the range, azimuth, and altitude data reported by the radar (Thomas, 1990). Little could be done about altitude errors; they can be attributed solely to the quality and calibration of the aircraft's altimeter and are simply reported to the ground in a Mode C transponder message to the secondary radar. Range and azimuth errors have both a random and a fixed component, and are the result of radar measurement, and, in some cases, the calibration of the aircraft transponder. While the random component can be characterized, the fixed component can normally be identified and removed leaving a higher quality track file.

Small random errors that occur in the beacon range are caused by varying received signal strength at the transponder; signal strength varies inversely with the square of the distance from the radar, but can also be affected somewhat by atmospheric conditions. This error is related to the transponder's ability to exactly determine the edge of the beacon interrogation pulse even when the signal gets weak. The error is typically small compared to the transponder turnaround time fixed error which exists because of manufacturing tolerances. The allowable error limit in the transponder turnaround delay (3.0 ± 0.5 μs) can build as much as a ±245 foot range bias into the beacon range report. This figure was considerably larger than the standard deviation of the runway lateral deviation error observed in STL samples near touchdown. (See Thomas, 1990 for information on tests conducted on transponder delay error.) Other random range errors can occur during the radar reinforcement process in the SRAP when a primary report can be "correlated" to a beacon report. Correlation is attempted when the two reported targets are within a parameter range (perhaps 300 feet) of each other. Since the primary radar requires detection of very small packets of reflected radio frequency (RF) energy at its antenna, its range measurement will have considerably more random noise than the beacon radar which receives relatively strong RF transmissions from the aircraft transponder. The reinforcement process in the SRAP assumes that the actual data point is somewhere between the primary and secondary reported position; it uses a weighted averaging technique to calculate that point. Therefore, the relatively noise free beacon range measurement can actually be somewhat corrupted by primary radar noise during reinforcement. The averaging weights are normally set to 50-50 percent. Since correlation often falls between 60 and 70 percent, this effect always has to be dealt with.

Fixed errors occur in the reported range primarily due to imperfect adjustments or drift found in the radar or in the SRAP equipments, or the transmission link connecting them. The SRAP has bias adjustments for both primary and beacon range to compensate for these errors; however, there were no high quality "benchmarks" to calibrate the equipment against. This is particularly true with the primary radar where "permanent echoes" are placed at known points, but these points are typically close to the radar and low to the ground, and are not collocated with the beacon parrot. Since fine adjustment of the SRAP is a very tedious task, particularly with the software tools in the ARTS available to assist, extremely accurate adjustment (within 50 feet) is not attempted or required. Nonetheless, these errors can be determined each time and later removed from the data.

The random component of the azimuth bias is related to the SRAP's ability to determine the centroid of the radar replies received for a particular target. Missing replies during the hit count leaves holes or gaps that the SRAP has

difficulty dealing with; as the signal strength decreases (at greater distances) this generally becomes more of a problem.

The fixed component of azimuth error is related to the occurrence of the north mark (0 ACP) with actual magnetic north. This error changes over time as magnetic declination changes; it can be adjusted to the proper value at the radar or by using an azimuth bias setting in the SRAP. Since magnetic declination continually changes with time (and we do not continually recalibrate), the true north that we calculate from the reported magnetic north will almost always have a fixed azimuth bias.

The azimuth and range contribution to centerline lateral deviation error near touchdown were estimated from the cosine and sine, respectively, of the angle between the runway centerline and a line from the radar site to the runway threshold. For small angles, random azimuth error would be a more significant factor in centerline deviation error than range error. As this angle increased (up to 90°), range error would tend to be the predominate cause of centerline deviation error. The centerline lateral deviation error was more significant for some runways than others at STL. Generally for STL data, it can be seen that the larger the range contribution to the error at landing, the greater the lateral deviation error for a given runway (table 1). This indicated that the majority of random error was due to range error.

The varying range and azimuth contributions to error at touchdown were due to the orientation of radar with respect to runways 06, 12L, 12R, 24, 30L, and 30R (figure 15). Taking the amount of transponder delay error into consideration, along with the radar-runway orientation at STL, the magnitude of the random error in the STL data near touchdown could be considered reasonable. It must be remembered that the error in the range measurement, caused by the transponder delay error, resulted in a random error for the data sample because of the large number of transponders in the sample, one for each aircraft. Due to the random nature of this error, it is impossible to reliably remove it.

6.2.2 Data Fidelity Moving Away From Touchdown.

The situation of STL radar coverage at touchdown was unique due to target altitude and radar/runway orientation. STL radar measurement accuracy during the approach to touchdown was a different situation. The radar measurements on the approach were not subject to the problems associated with low altitude; i.e., missed and reflected reports, since the target was always high enough. However, the measurements were still subject to range and azimuth errors. Once again the radar/runway orientation was the main factor because of the requirement to determine how well an aircraft flew its assigned approach coarse centerline. In theory, for all of the STL runways, the further the aircraft was from touchdown, the more the deviation from course centerline was dependent on azimuth measurement. Unfortunately, it was difficult to determine the accuracy of radar reports for individual aircraft, because many aircraft in a given sample did not follow a straight line approach to landing. In all sessions there were aircraft that turned on to the approach centerline as close as 1 to 1-1/2 miles from the touchdown point.

TABLE 1. RUNWAY CENTERLINE DEVIATION ERROR AT TOUCHDOWN

Rwy	Azimuth Contribution (%)	Range Contribution (%)	Average Standard Deviation at 0.45 nmi	Days Data Collected
6	34	66	79 feet	3
12L	25	75	64 feet	10
12R	62	38	52 feet	11
24	63	37	37 feet	13
30L	68	32	31 feet	12
30R	65	35	35 feet	13

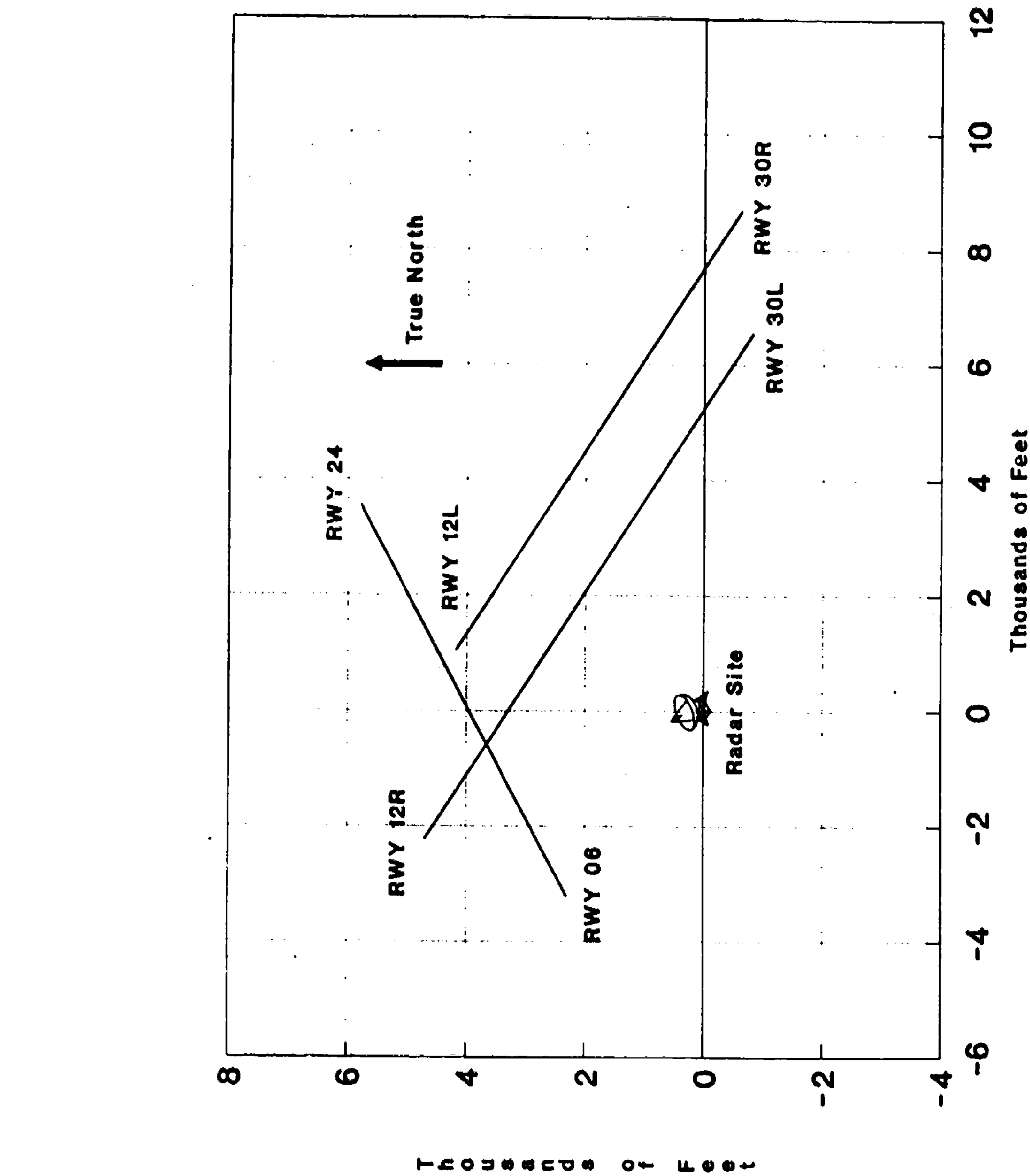


FIGURE 15. RELATIONSHIP OF RADAR SITE AND RUNWAYS

6.3 SUMMARY.

When considering an aircraft that had turned onto and was flying the final approach at STL, the collected radar data exhibited some error. The error was composed of both a random component and a relatively constant component. The constant component was effectively removed via the parrot transponder procedure discussed in section 5, but the random component could not be reliably identified and removed. The amount of error at touchdown was also affected by the radar's orientation to the runway (figure 15). It appeared that the greater the range contribution to the lateral measurement about the extended runway centerline at touchdown, the greater the random error for a given runway (table 1).

7. PROJECT SCHEDULE AND MILESTONES.

STL data collection was completed by October 1990. The requested data for August, September, and October 1990, were delivered in March 1991. In April 1990, AVN-540 perceived a need for an additional 19 days of data in September and October and requested that this data be processed and sent out to them. These additional and unforseen requests necessitated that the planned completion dates for data delivery to AVN-540 and the final report be pushed back.

Milestone	Completion Date
a. Installation and on-site test of DUALSRAP Data Collection System at STL.	7/90
b. Start Data Collection for St. Louis.	8/90
c. End Data Collection for St. Louis.	10/90
d. Initial delivery of STL Database and Plots to AVN-540.	3/91
f. Delivery of additionally requested STL data to AVN-540.	7/91
g. Publish Technical Note on STL results.	10/92

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LIST OF ACRONYMS

ACP	Azimuth Change Pulse
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
ATIS	Automatic Terminal Information Service
ACP	Azimuth Change Pulse
BDAS	Beacon Data Acquisition Subsystem
DASI	Digital Altimeter System Indicator
DOS	Disk Operating System
EBL	Extended Batch Language
FAA	Federal Aviation Administration
ID-DAS	IDentification Data Acquisition System
IDSM	Interfacility Data System Microprocessor
IFR	Instrument Flight Rules
ILS	Instrument Landing System
I/O	Input/Output
LAN	Local Area Network
m.s.l.	Mean Sea Level
NAS	National Airspace System
NBS	National Bureau of Standards
nmi	Nautical Mile
NOZ	Normal Operating Zone
NWS	National Weather Service
ORD	Chicago O'Hare International Airport
PAM	Peripheral Adapter Module
PIM	Peripheral Interface Module
RDAS	Radar Data Acquisition Subsystem
SA	Surface Observation
SFO	San Francisco International Airport
SP	Special Report (Weather)
SRAP	Sensor Receiver and Processor
STL	Lambert-St. Louis International Airport
TB	Terminate Beacon
TRACON	Terminal Radar Approach Control
ZCK	Kansas City Air Route Traffic Control Center

APPENDIX A

DATA FILES

Two types of data files are described in this appendix. Raw data files consist of data collected in the field, both at Lambert-St. Louis International Airport (STL) and at the Federal Aviation Administration (FAA) Technical Center. Reduced data files consist of data that has been converted to a format compatible with the analysis environment.

A.1 RAW DATA FILES.

Raw Sensor Receiver and Processor (SRAP), Interfacility, and Digital Altimeter Setting Indicator (DASI) data were collected on-site at STL. Raw weather data were collected at the FAA Technical Center. The following is a description of the raw data files created at the time of field collection.

A.1.1 SRAP.

The raw SRAP data were recorded onto disk using the filename format Smddhhmm.DAT:

where: S = The letter "S"
m = The month (1 thru 9, A for October, B for November, and C for December)
dd = Day of month-2 digits (01 to 31)
hh = Hour of start of test (00 to 23)
mm = Minute of start of test (00 to 59)

From the raw SRAP file the following data was extracted:

a. Time in hours, minutes, seconds referenced to STL (Central time)

b. Radar sector number

c. SRAP channel number (0)

d. Slant range in nmi from radar

e. Azimuth Change Pulse (ACP) (0 thru 4096)

f. Azimuth in degrees

g. Quality (0 thru 7)

h. Special Position Indicator (SPI) (not used)

i. Beacon code (0000 thru 7777)

j. Beacon code validity (0 thru 3)

k. Altitude in hundreds of feet (uncorrected)

l. Altitude validity (0 thru 3)

m. Beacon hit count

n. Message type (BO for beacon only, RB for radar reinforced beacon)

A.1.2 INTERFACILITY.

The interfacility data were recorded onto disk using the filename format Imddhhmm.AOL (for more information on "mddhhmm", see A.1.1). The interfacility data file contained the following data:

a. ARR (arrival)

b. Time in hours and minutes with respect to STL

c. Beacon code (0000 thru 7777)

d. ACID (e.g., UAL923)

e. ACTYPE (e.g., B737)

f. Approach fix (e.g., JOT)

g. Altitude at fix in hundreds of feet (e.g., 100 for 10,000 feet)

A.1.3 DASI.

DASI data were recorded onto disk using the filename format Smddhhmm.RCM (for more information on Smddhhmm, see A.1.1).

A.1.4 WEATHER.

The raw weather data were collected on an FAA Technical Center computer by logging on the Kavouris Inc. weather data base and requesting the day's weather reports for STL. The data were recorded onto a disk file whose name had the format WXmmddyy.TXT:

where: WX = The letters "WX"
mm = The month - 2 digits (01 thru 12)
dd = Day of month - 2 digits (01 to 31)
yy = Year - 2 digits (00 to 99)
. = "."
TXT = The letters "TXT"

The weather file consisted of weather reports, each report containing the following data:

a. Date in month/day/year

b. Time in hours and minutes (Zulu)

d. Report type (SA or SP or RS)

e. Lowest ceiling type (E or M or W)

f. Lowest ceiling height in hundreds of feet

g. Lowest sky descriptor (OVC or CLR or BKN or ...)

h. Next lowest ceiling type (E or M or W)

i. Next lowest ceiling height in hundreds of feet

j. Next lowest sky descriptor (OVC or CLR or BKN or ...)

k. Visibility in nmi

l. Weather (rain or fog or snow or ...)

m. Sea level pressure in millibars

n. Temperature in degrees fahrenheit

o. Dewpoint in degrees fahrenheit

p. Wind direction in tens of degrees referenced to true north

q. Wind speed in knots

r. Wind gust in knots

s. Altimeter setting in inches of mercury

t. Remarks

Note: for more information on these data refer to the Aviation Weather Services Manual, AC 00-45B, published jointly by FAA and NOAH.

A.2 DATA REDUCTION FILES.

Raw SRAP, Interfacility, DASI, and weather data files were unpacked and reduced at the FAA Technical Center. The following is a description of the Data Reduction files created from the raw data files.

A.2.1 DATA REDUCTION TRACK FILES.

The track files created during the reduction process consisted of all the position reports for a single aircraft's approach. The type and format of the information contained in each track file type are:

FILENAME ==> MEANING

_acid.rwy ==> Raw track file (SRAP 0) (output of TRACKS)
Data: HR,MN,SEC,CH,RANGE,AZMTH,BC,ALT,TYPE

@acid.rwy ==> Corrected track file (SRAP 0) (output of GAP)
Data: HR,MN,SEC,CH,RANGE,AZMTH,BC,ALT,TYPE

$acid.rwy ==> GAP documentation file (SRAP 0)
Data: list of missing scans and altitudes and multiple scans

&acid.rwy ==> Translated to runway, corrected track file (SRAP 0) (output of PTTRANS)
Data: HR,MN,SEC,X,Y,Z

'acid.rwy ==> Smoothed, translated, corrected track file (SRAP 0) (output of SM)
Data: HR,MN,SEC,X,Y,Z

(acid.rwy ==> Interpolated, smoothed, translated, corrected track file (SRAP 0) (output of INTERP)
Data: HR,MN,SEC,X,Y,Z

where: acid ==> Aircraft ID (AAL1115, UAL100, ...)
rwy ==> Runway designator (12L, 12R, ...)

A.2.2 DATA REDUCTION INTERFACILITY FILES.

The interfacility data files created during the reduction process consisted of the data extracted from the raw interfacility data files; however, these file data were converted to a Foxbase data base format.

Imddhhmm.DBF ==> Interfacility data in a Foxbase data base format
Data: (See A.1.2)

A.2.3 DATA REDUCTION DASI FILES.

The DASI data files created during the reduction process consisted of DASI data extracted from the raw DASI data files. The reduced data files were converted to Foxbase data base format.

Rmddhhmm.DBF ==> DASI data in a Foxbase data base format
Data: Digital Altimeter Setting Indicator (DASI)

A.2.4 DATA REDUCTION WEATHER FILES.

The weather data files created during the reduction process consisted of the data present in the raw weather data files. The reduced data files were converted to a Foxbase data base format and merged with the MASTER data base (see appendix C).

```
WXmmddyy.FIX ==>  Preprocessed and corrected weather data file
    Data:         (See A.1.4)

WXmmddyy.DAT ==>  Weather data for one day in Foxbase data base compatible
                  format
    Data:         (See A.1.4)

STLmmm.DAT   ==>  Weather data for one month (mmm = Jan, Feb, etc.)
```

APPENDIX B

DATA REDUCTION

The data collected at the site were brought back to the Federal Aviation Administration (FAA) Technical Center where it was reduced to a form to be used in the final analysis. Unpacking was the process whereby data, recorded in a foreign format for purposes of space and efficiency, was converted to a format compatible with the analysis environment. Reduction was the process of coordinate conversion, filtering, smoothing, and interpolation of the unpacked radar data. Each of the raw data files identified in appendix A had to be unpacked. The unpacking and reduction procedures are described here.

B.1 SRAP AND INTERFACILITY DATA.

The radar data collected via the Sensor Receiver and Processor (SRAP) required considerably more processing than any other type of data collected to prepare it for analysis. Unpacking and reduction of the radar data involved:

a. Conversion to engineering units and sorted according to beacon code.

b. Deletion from further processing if any of the following were detected; large gap(s) in the track, track was of short duration, or no Mode C altitude and altitude can't be had from other sources.

c. Conversion to (time, x,y,z), then translation and rotation to the runway threshold being approached.

d. Filtering and smoothing of radar data to eliminate radar outliers and to obtain a more accurate estimate of aircraft position.

e. Interpolation to attain estimates of cross-track deviation at specific points along the Instrument Landing System (ILS) approach.

The following software programs performed these processes on the raw SRAP data with the following results.

B.1.1 TRACKS.FOX.

--> language: Foxbase +2.10 programming language

--> input:
- a. Smddhhmm.DAT (raw SRAP data file)
- b. Imddhhmm.AOL (raw Interfacility data file)

--> process:
- a. Invoked SRAPUNPK.PAS to unpack raw SRAP data and produced SRAP Foxbase data base file Smddhhmm.DBF
- b. Indexed Smddhhmm.DBF by session and beacon code
- c. Identified tracks with sufficient number of scans
- d. Determined runway being approached for each track
- e. Cross referenced SRAP data with interfacility data file Imddhhmm.AOL to obtain aircraft ID (ACID) and aircraft type (ACTYPE) for each beacon code

f. Appended a record to the master data base (MASTER.DBF) for each identified track (see appendix C)

--> output: a. Created directory "Smddhhmm" and placed ASCII aircraft track files _acid.RWY for SRAPO into this directory (see A.2)
b. Appended one record for each identified track to the MASTER data base (see appendix C)

B.1.2 SRAPUNPK.PAS.

--> language: Turbo PASCAL 5.0

--> input: Smddhhmm.DAT (raw SRAP data file)

--> process: Unpacked beacon and radar reinforced beacon messages only

--> output: Smddhhmm.DBF (Foxbase data base format)

B.1.3 GAP.C.

--> language: Turbo C 2.0

--> inputs: a. All _acid.rwy files (raw track files)
b. MASTER.DBF master data base (optional, depends on version of GAP.C)

--> process: a. Deleted illegal multiple scans
b. Added missed altitudes
c. Altitude correction based on airport altimeter setting
d. Identified large time gaps and determined if the pre-gap and post-gap data are from the same track
e. Produced documentation explaining results

--> outputs: @acid.rwy (SRAPO) corrected track files (A.2.1)
$acid.rwy (SRAPO) documentation files (A.2.1)

B.1.4 PTTRANS.C.

--> language: Turbo C 2.0

--> inputs: All @acid.rwy files (corrected track files)

--> process: a. Converted data from (rng,az,alt) to (x,y,z)
b. Translated data to runway threshold identified in filename

--> outputs: &acid.rwy (SRAPO) translated and corrected track files (A.2.1)

B.1.5 SM.C.

--> language: Turbo C 2.0

--> inputs: All &acid.rwy files (translated and corrected track files)

--> process: Filtered and smoothed using Lincoln Lab's radar smoothing algorithms

--> outputs: 'acid.rwy (SRAPO) filtered, smoothed, translated, and corrected track files (A.2.1)

B.1.6 SPLINE.C.

--> language: Turbo C 2.0

--> inputs: All 'acid.rwy files (filtered, smoothed, translated, and corrected track files)

--> process: Inserted an interpolated data point (time,x,y,z) at each 0.15 nmi X increment

--> outputs: (acid.rwy (SRAPO) interpolated, filtered, smoothed, translated, and corrected track files (A.2.1)

B.2 DASI DATA.

The raw DASI data were processed by the following programs with the described results.

B.2.1 RCMSUPK.PAS.

--> language: Turbo Pascal 5.0

--> inputs: Smddhhmm.RCM (raw RCMS data file)

--> process: Unpacked DASI data and put it into a Foxbase data base format

--> outputs: Rmddhhmm.DBF (unpacked DASI data in Foxbase format)

B.3 WEATHER DATA.

The weather data for Lambert-St. Louis International Airport (STL) required some preprocessing before it could be unpacked by the weather data unpacking program, STLWX.BAS. The weather data preprocessing and unpacking procedures are described here.

Preprocessing a weather data file consisted of:

a. Removed correction weather reports and blank lines between weather reports.

b. Added, if necessary, a ")" to the end of the weather data file as an End of File marker (EOF).

c. Checked that the first line of each weather report had at least one "/" in it. STLWX.BAS needed at least one "/" in the first line of a weather report to process that report properly.

Unpacking the preprocessed weather data files created one Foxbase data base compatible file for each day and one Foxbase data base compatible file for each month of weather data files.

B.3.1 CORRECT.BAS.

--> language: Turbo BASIC 1.0

--> input: WXmmddyy.TXT (raw weather data file)

--> process:
a. Kept last correction weather report in data file, all previous correction reports and the original report were removed from the weather data file
b. Removed blank lines between weather reports in a file
c. Added, if needed, a ")" to the weather data file as an EOF marker

--> output: WXmmddyy.FIX (corrected weather data files)

B.3.2 SLASH.BAS.

--> language: Turbo BASIC 1.0

--> input: WXmmddyy.FIX (corrected weather data file)

--> process: Counted the number of "/" in first line of each weather report

--> output: WXmmyy.BAD (listing by time for each ".FIX" file of weather reports with less than five "/" in their first line)

B.3.3 STLWX.BAS.

--> language: Turbo BASIC 1.0

--> input: WXmmddyy.FIX (corrected weather data file)

--> process: Unpacked a weather data file to produce a Foxbase data base compatible record for each weather report and reordered records by time and date in ascending order in the output files

--> outputs: WXmmddyy.DAT (unpacked weather data file)
STLmmm.TOT (combined WXmmddyy.DAT files for one month, where mmm = JAN, FEB, MAR, etc.)

B.3.4 STRU.DBF.

--> language: Foxbase +2.10 programming language

--> input: STLmmm.TOT (combined WXmmddyy.DAT files)

--> process: STRU.DBF was a data base structure with fields for the data contained in a weather report, it was copied to WX_mmm.DBF. The data in the STLmmm.TOT file was then added to WX_mmm.DBF using the Foxbase APPEND command.

--> output: WX_mmm.DBF (weather data for 1 month in Foxbase data base format)

Certain weather data base fields were next merged with the Master Data base (see appendix C).

B.4 PARROT TRANSPONDER DATA.

Parrot data statistics were extracted from the raw SRAP data, to assist in the calculation of the radar range and azimuth biases, using the program described below.

B.4.1 TC_PAROT.FOX.

--> language: Foxbase +2.10 programming language

--> input: Smddhhmm.DBF (Foxbase data base format)

--> process: Collected, unpacked, analyzed, and produced a statistical report on the quantity and quality of the Parrot transponder data

--> output: A printout of a report containing values for the mean and standard deviation of both range and azimuth, and the ACP skewness and kurtosis of the azimuth

APPENDIX C

MASTER DATA BASE

Prior to data analysis all unpacked data were merged into a data base that identified each approach collected. This data base was referred to as the MASTER data base. Data used to construct the MASTER data base consisted of information about each track and the weather at the time of the track's collection. The MASTER data base did not contain the tracks' radar position data however. The radar position data for each track was instead stored in the individual track files (refer to A.2.1).

The MASTER data base contained one record for each approach. The record had a field for each track characteristic. Since the format of the MASTER data base was developed for an earlier data collection effort, there were some fields in the data base not used for the Lambert-St. Louis International Airport (STL) data collection effort.

C.1 MASTER DATA BASE FIELDS.

For purposes of clarity all the MASTER data base record fields are shown on a single page in figure C.1.

C.2 MASTER DATA BASE GENERATION.

The MASTER data base (_MASTER.DBF) was generated in a multistep process. Only the following fields were used in the STL data collection.

Field	Description
1	Test or session name (e.g., S2131453)
2	SRAP channel # (0 or 1)
3	Aircraft ID (e.g., UAL9253),
4	User type (Military, Commercial,...)
5	Aircraft type (e.g., B727)
6	Beacon code (0000 thru 7777)
7	Month/day/year of collection
8	Time of day of first scan for the track
9	Time of day of last scan for the track
10	Altitude of first scan for the track
11	Altitude of last scan for the track
12	Number of scans for the track
13	Runway being approached
28	Temperature in degrees fahrenheit during track
29	Dewpoint in degrees fahrenheit during track
30	Ceiling type (M or E or W)
31	Ceiling height in feet
32	Visibility in nautical miles
33	Weather (Fog and/or Rain and/or Snow,...)
34	Wind speed in knots
35	Wind direction in degrees from true north
42	Barometric pressure in inches of mercury
43	Distance X at which A/C is stabilized on localizer

Field	Field Name	Type	Length	Description
1	SESSION	Chr	8	Test name (e.g., S2131453) (see A.1.1)
2	CH	Num	1	Channel # (0 or 1) of SRAP
3	AC_ID	Chr	7	Aircraft ID (e.g., UAL9253)
4	USER_TYPE	Chr	1	User type (Military or Commercial or ...)
5	AC_TYPE	Chr	5	Aircraft type (e.g., B727)
6	BEACON	Chr	4	Beacon code (0000 thru 7777)
7	DATE	Date	8	Month/day/year of collection
8	START_TIME	Chr	11	Time of day of first scan for the track
9	STOP_TIME	Chr	11	Time of day of last scan for the track
10	START_ALT	Num	6	Altitude of first scan for the track
11	STOP_ALT	Num	6	Altitude of last scan for the track
12	TARGET_CT	Num	4	Number of scans for the track
13	RUNWAY	Chr	3	Runway being approached
14	MIN_X	Num	8	Minimum distance from threshold
15	T_AT_4_NMI	Chr	11	Time of day at 4 nmi from threshold
16	MAX_Y_TNTZ	Num	6	Maximum lateral deviation from ILS towards NTZ
17	XMAXY_TNTZ	Num	8	Distance from threshold at MAX_Y_TNTZ
18	MAX_Y_ANTZ	Num	6	Maximum lateral deviation from ILS away from NTZ
19	XMAXY_ANTZ	Num	8	Distance from threshold at MAX_Y_ANTZ
20	MAX_Z	Num	6	Maximum altitude for the track
21	MIN_Z	Num	6	Minimum altitude for the track
22	MEAN_Y	Num	6	Average ILS deviation from stabilization to TD
23	MEAN_XDOT	Num	8	Average velocity of A/C during ILS approach
24	STD_DEV_Y	Num	6	Standard deviation of ILS lateral deviation
25	IN_NTZ	Log	1	.TRUE. if A/C in NTZ after stabilization
26	NTZ_DIS	Num	6	Width of NOZ in feet
27	X_AT_VIO	Num	8	Distance from threshold at first NTZ violation
28	TEMP	Num	3	Temperature in degrees fahrenheit during track
29	DEWPT	Num	3	Dewpoint in degrees fahrenheit during track
30	CEIL_TYPE	Chr	1	Ceiling type (M or E or W)
31	CEILING	Num	5	Ceiling height in feet
32	VISIBILITY	Num	5	Visibility in nmi
33	WEATHER	Chr	4	(Fog and/or Rain and/or Snow and/or ...)
34	WIND_SPEED	Num	2	Wind speed in knots
35	WIND_DIR	Num	3	Wind direction in degrees from true north
36	LLWAS_SPD	Num	2	Low level windshear alert system speed in knots
37	LLWAS_DIR	Num	3	Low level windshear alert system direction deg
38	LLWAS_GUST	Num	2	Low level windshear alert system gusts in knots
39	CFA_SPD	Num	2	Low level windshear alert system center field ws
40	CFA_DIR	Num	3	Low level windshear alert system center field wd
41	RVR	Num	4	Runway visual range in feet
42	BRMTR	Num	5	Barometric pressure in inches of mercury
43	STBL_X	Num	5	X at which A/C is stabilized on localizer
44	PAIR_LDR	Chr	7	Leading adjacent localizer AC_ID (if it exists)
45	PAIR_TRL	Chr	7	Trailing adjacent localizer AC_ID (if it exists)
46	GAP_START	Chr	11	Raw track file start time (as determined by GAP)
47	GAP_STOP	Chr	11	Raw track file stop time (as determined by GAP)
48	GAP_STRT_R	Num	6	Raw track file initial range
49	GAP_STOP_R	Num	6	Raw track file final range
50	GAP_NUM	Num	3	Number of scans in raw track file
51	GAP_MS_SCN	Num	3	Number of missing scans in raw track file
52	GAP_DOUBLE	Num	3	Number of double scans in raw track file
53	GAP_ALT	Num	3	Number of missing or unreasonable altitudes

Total of 282 bytes/record

FIGURE C-1. MASTER DATA BASE RECORD STRUCTURE

The processes that generated the MASTER data base are identified and described in the following paragraphs:

C.2.1 TRACKS.FOX.

TRACKS.FOX was the same process identified and partially described in B.1.1. In addition to the identification and unpacking of the individual track files, it also appended one record to the MASTER data base for each track. TRACKS.FOX filled in data fields 1 through 13: (1) session, (2) channel, (3) ACID, (4) user-type, (5) A/C-type, (6) beacon code, (7) date, (8) start time, (9) stop time, (10) start altitude, (11) stop altitude, (12) target count, and (13) runway for each aircraft track.

C.2.2 WX_APP.FOX.

This process appended fields (28) temperature, (29) dewpoint, (30) ceil_type, (31) ceiling, (32) visibility, (33) weather, (34) wind speed, (35) wind direction, and (42) barometer pressure by time and date to records in the MASTER data base.

--> input:	WX_mmm.DBF (weather data base files, see B.3.4)
--> process:	Merged fields from weather data base with the appropriate fields in the MASTER data base
--> output:	Modified MASTER data base weather fields cited above

C.2.3 STABLE_X.

STBL_X (43) was the distance from the end of the runway on the X axis at which the approaching aircraft is considered stabilized on the localizer. This value was not calculated for STL tracks. However, a value was needed in this field to run analysis software; for this purpose a value of 4 nmi was used.

APPENDIX D

STL DATA COLLECTION REFERENCE MANUAL

D.1 SRAP DATA COLLECTION.

The automatic Sensor Receiver and Processor (SRAP) data collection software ran at the Lambert-St. Louis International Airport (STL) Terminal Radar Approach Control (TRACON) in support of the Visual Approaches Data Collection Project (F20-06G). The data collection software consisted of various programs invoked by a batch file on the SRAP data collection computer (IBM PC XT). The batch file, RUN_STLV.BAT, was initiated from the AUTOEXEC.BAT file after the computer was rebooted each morning. The batch program initiated the following steps.

D.1.1 INITIALIZE DOS CLOCK.

ASTCLOCK.COM was an off-the-shelf program used to initialize DOS time to the time kept by the clock on the AST board.

D.1.2 WAIT PROGRAM.

WAIT0600.PRG was an ACD-340 written Foxbase program which looped until the DOS time-of-day was between 0600 and 2200 hours. WAIT0600.PRG then terminated and allowed RUN_STLV.BAT to continue.

D.1.3 BATCH FILE CREATION.

RUN_STLV.BAT immediately started FILENAME.PRG. FILENAME.PRG was an ACD-340 written Foxbase program which created two batch files (FILENAME.BAT and DELE_CHK.BAT). These files renamed, copied, and deleted the data collection files after SRAP data collection ended. The filenames created by FILENAME.PRG were based on the current date and time of day in order to uniquely identify the daily SRAP data collection files. For more information on these batch files see D.1.3, D.1.4.2, and D.1.4.4.

D.1.4 DATA COLLECTION PROGRAM.

FASTSRAP.EXE was an ACD-340 written 8088 assembly language program which collected and stored SRAP, DASI, and message data (SRAP.DAT, RCMS.DAT, and MESS.DAT) to the C:\DATA subdirectory. For more information on the SRAP and DASI data files see A.1.1 and A.1.3. The message data file was a listing of messages generated by FASTSRAP.EXE during execution, these messages were not used during the data analysis. FASTSRAP.EXE ran from whenever it was started until 2200 hours (Central time).

D.1.5 BREAKOUT AREA.

WAIT10.COM was an off-the-shelf program that waits 10 seconds. This gave an interactive user a chance to halt RUN_STLV.BAT after FASTSRAP.EXE terminated. RUN_STLV.BAT would have to be halted if an error occurred during the execution of FASTSRAP.EXE.

D.1.6 FILE TRANSFER.

After data collection terminated the IBM XT attempted to log on to the network and then initiated FILENAME.BAT. FILENAME.BAT renamed the SRAP, DASI, and message data files, created by FASTSRAP.EXE, to Smddhhmm.DAT, Smddhhmm.RCM, and Smddhhmm.MES, respectively (for more information on "mddhhmm" see A.1.1).

FILENAME.BAT then checked that the network was up, if so, then it copied the renamed SRAP, DASI, and message data files to the J:\STL\DATA directory.

D.1.7 FILE BACKUP.

The file backup process consisted of a Wait program, a Primary backup, a Secondary backup, and deletion of old SRAP data files. After this, the SRAP data files were deleted from the C:\DATA subdirectory only if they were successfully copied to the network J: drive when FILENAME.BAT executed.

D.1.7.1 Wait Program.

WAIT0005.PRG was an ACD-340 written Foxbase program which loops until DOS time is between 12:05 a.m. and 12:30 a.m. It then terminated, allowing RUN_STLV.BAT to perform the tape backup.

D.1.7.2 Tape Backup.

TAPEBACK.BAT accomplished a tape backup by invoking TAPEBCK1.BAT. TAPEBCK1.BAT performed a Primary and Secondary backup of the SRAP and interfacility data files in the J:\STL\DATA subdirectory which had not been backed up previously; i.e., those files that had their archive bit set. If the IBM XT did not successfully log on to the network, TAPEBCK1.BAT would backup the data present on the C:\DATA subdirectory. The primary tape's subdirectory was stored in the C:\DATA\BACKUP subdirectory as TAPEDIR1.TXT. The secondary tape's directory was then stored in C:\DATA\BACKUP subdirectory as TAPEDIR2.TXT.

D.1.7.3 Deletion of SRAP Data Files on C:\DATA.

TAPEBACK.BAT also invoked DELE_CHK.BAT. DELE_CHK.BAT checked that the day's SRAP data files were successfully copied to the J: drive (see D.1.3). If the files existed on J: then DELE_CHK.BAT went ahead and deleted those day's SRAP data files from the C:\DATA subdirectory. Any additional data files in the C:\DATA subdirectory were copied to the C:\DATA\BACKUP subdirectory. This saved any SRAP data files created before a system crash, but not previously backed up. The C:\DATA\BACKUP subdirectory was checked weekly for data files, any files found were copied to the J:\STL\DATA subdirectory and then deleted from the IBM XT C: drive.

D.1.8 RESET AST CLOCK.

ASTCLOCK.COM was used to reset the clock on the AST board to DOS time (DOS time was set to WWVB time at the beginning of data collection).

D.1.9 SYSTEM REBOOT.

After the tape backup process was completed in the early morning hours, REBOOT.COM was executed. REBOOT.COM was an off-the-shelf program used to perform a soft reboot of the IBM XT. The IBM XT was rebooted to remove any Terminate and Stay Resident (TSR) programs initiated when the system logged on to the network. After the system rebooted, RUN_STLV.BAT was restarted.

D.2 INTERFACILITY DATA COLLECTION.

The following is an explanation of the Landrum & Brown (L&B) ARTS IDentification Data Acquisition System (ID-DAS) software which ran at the STL TRACON. This process was invoked by ISTL_RUN.BAT on the Interfacility data collection computer (IQ-Plus XT compatible). ISTL_RUN.BAT was initiated by an appointment scheduling program each morning at 0500 (Central time). Interfacility data collection began 1 hour before SRAP data collection because of the possibility of up to 1 hour difference between the receipt of interfacility data for an aircraft and that aircraft's arrival time. The batch program initiated the following steps.

D.2.1 DELETION OF OLD INTERFACILITY DATA FILES.

DOS code was used to check for the presence of Interfacility data files (Imddhhmm.AOL, see A.1.1) on the C:\AOL subdirectory. If data files were present, they were deleted from C:\AOL.

D.2.2 DATA COLLECTION PROGRAM.

IDPTC.EXE was the executable program IDentification Processor/TC that collected and stored the interfacility data to the C:\AOL subdirectory. IDPTC.EXE always started interactively. IDP.INP was a redirected input ASCII file containing the responses needed to initialize IDPTC.EXE. The responses are explained below:

2	Processing mode = ARRIVALS
N	Include all aircraft ID's
Y	Copy all ARTS Interfacility (IF) messages pertinent to ID-DAS to a buffer file
STL DATA	Processing title
Y	Specify Start and Stop time
B	Begin data collection immediately upon program execution
S	Specify Stop time
22,00	Stop time = 2200 hours
STL	Output filename for buffer file (STL.AOL)
<rtn>	Sets default output filename for data file (default Imddhhmm.AOL)
C:\AOL\STLDATA	File root for buffer file

D.2.3 FILE BACKUP.

The daily Interfacility data file was backed up on the C:\AOL\ARRIVALS subdirectory and the J:\STL\DATA subdirectory. Interfacility data files in the J:\STL\DATA subdirectory were later backed up on tape along with SRAP data files.

D.3 WEATHER DATA COLLECTION.

The following is an explanation of the STL Weather Data Collection. The process was invoked by STL.BAT running on an IBM compatible computer located at the FAA Technical Center. STL.BAT was initiated by an appointment scheduling program each day at 2350 hours Eastern time (2250 hours Central time). The batch file executed software that logged onto the Kavouras weather network, requested the previous 30 STL weather reports, and saved these reports to a data file (WXmmddyy.TXT, see A.1.3). The batch program consisted of the following steps.

D.3.1 DATA COLLECTION PROGRAM.

PCWX started the communications program that accessed the Kavouras Weather Data Base. PCWX was set up to dial up the weather data base, log on to the data base, and to open up a capture buffer for any received data upon execution. Using the "EVENT" option, PCWX sent the command "SA/RPTS=30 STL" at 2355 hours. After the weather reports were received, they were saved to a weather data file. PCWX then automatically logged off the Kavouras Weather Data Base and exited to DOS.

D.3.2 FILE BACKUP.

That day's collected weather data file was copied to the C:\WEATHER\STL_RPTS subdirectory. The data file would be backed up to a Network drive by FAA technical personnel the following day.

D.3.3 DELETION OF OLD WEATHER DATA FILES.

DOS code was used to check for the presence of old weather data files in the C:\WEATHER subdirectory. If data files were found, they were deleted from C:\WEATHER.

☆U.S. GOVERNMENT PRINTING OFFICE: 1993 - 704-078/80024